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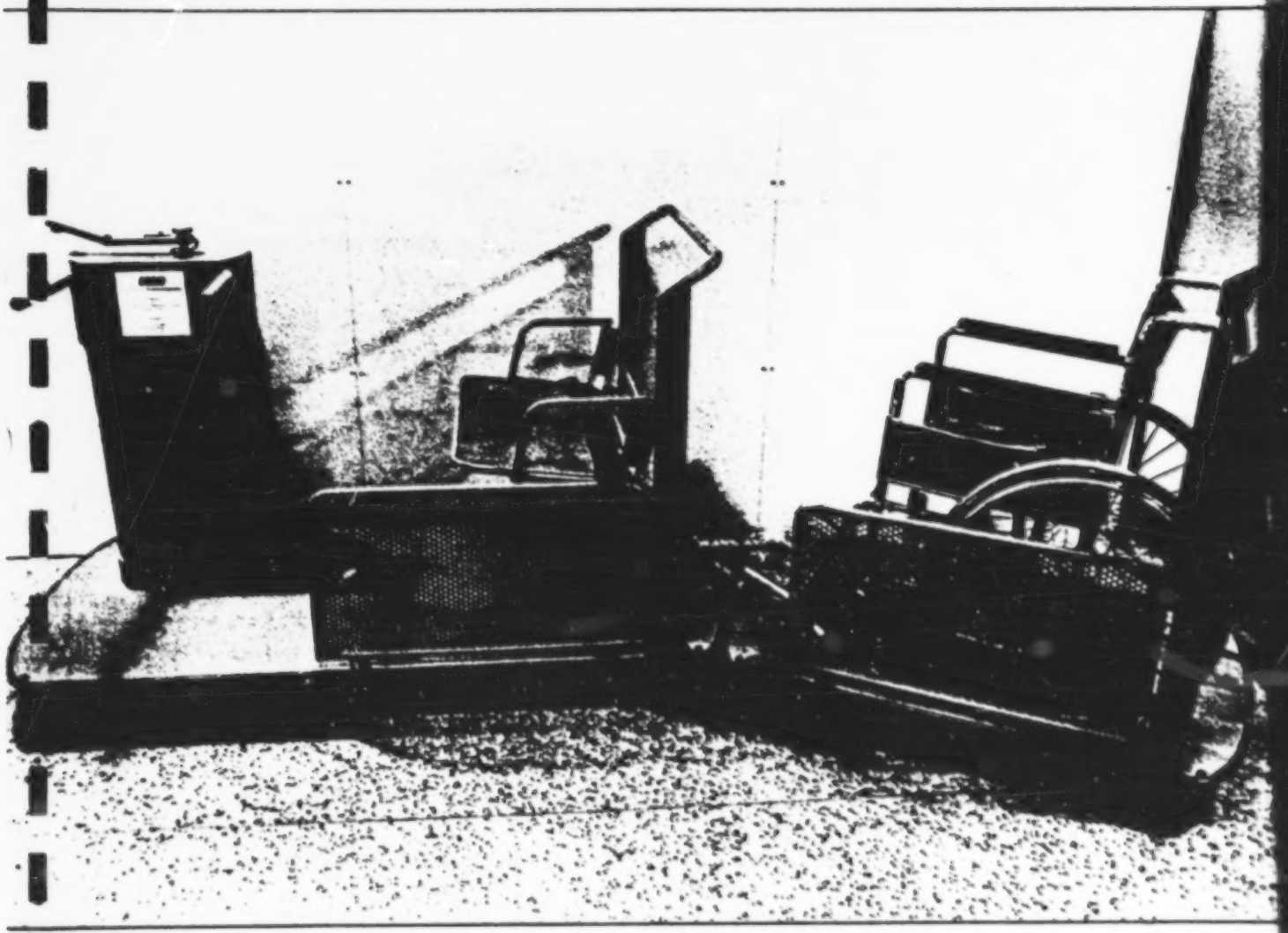

Modular Transfer Platform Development and Evaluation

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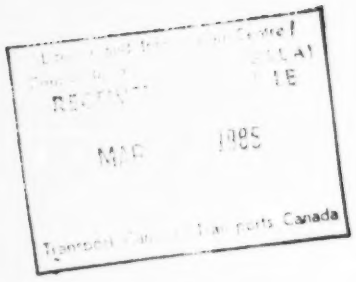
Modular Transfer Platform: Development and Evaluation

for

Transportation Development Centre
Transport Canada



by

Uwe Rutenberg, Michael Barber and Leon Goldik
Les Designers Douglas Ball Inc.

August 1984

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17. Abstract

This report describes the building and testing of Transfer Vehicle Platform prototypes designed for used in transportation terminals and other complexes where long distances create transfer problems for young, elderly and disabled persons.

The system consists of small, compact and light-weight platforms, one of which is motor driven by 12 V batteries and operated by a person standing beside the motor, facing either toward or away from the passenger; its use is for authorized personnel only. The other, a non-motorized platform, can be pushed by the passenger's companion in the public area and then linked to the motorized platform once in the restricted area.

The curved ends of the platforms keep the turning radius small. All platforms have a ramp for wheelchair access on one side, a folding seat and a handrail.

The evaluation consisted in a comprehensive set of test scenarios at Dorval Airport in Montreal. Results indicate that, with some minor modifications, this system will help to decrease physical load for carrier attendants assigned to transfer duties and increase efficiency of passenger-handling service. Disabled and elderly passengers would be provided with a comfortable, psychologically acceptable transfer service.

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17. Résumé

Ce rapport décrit les travaux de réalisation et d'essai du prototype d'un véhicule à plate-forme pour le transport des personnes à mobilité réduite et des handicapés, à l'intérieur des installations terminales et autres complexes immobiliers.

Ce véhicule se compose d'une plate-forme courte, compacte et légère attelée à une plate-forme motrice équipée de batteries 12 V et conduite par un préposé qui prend place debout à coté du bloc moteur et fait face au passager ou lui tourne le dos. La plate-forme non motorisée est poussée par le ou les accompanateurs jusqu'à l'entrée de la zone réglementée de l'aérogare, ou elle est attelée à la plate-forme motrice et prise en charge par le préposé.

Le rayon de braquage en est très court, grâce aux extrémités courbes. Les plates-formes ont toutes un siège pliant surmonté d'une barre horizontale pour pousser et un abattant servant de rampe d'accès pour le fauteuil roulant.

Les essais ont eu lieu à l'aéroport de Dorval à Montréal. Les résultats ont montré qu'avec de légères modifications, le véhicule pourra être mis à profit pour alléger l'effort physique requis des préposés, pour améliorer la qualité du traitement des passagers et, enfin, pour mettre à la disposition des personnes âgées et des handicapés un mode de transport intérieur à la fois confortable et psychologiquement acceptable par elles.

18. Mots-clés	19 Diffusion
Plate-forme motorisée, Véhicule, Transport, Handicapés, Personnes âgées, Mobilité réduite, Aérogares, Terminus	Le centre de développement des transports dispose d'un nombre limité d'exemplaires.

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SUMMARY

The lack of adequate facilities in Canadian transportation terminals to accommodate the growing population of elderly and physically handicapped persons prompted the submission of an unsolicited proposal to Transport Canada in 1982. The project was sponsored by Supply and Services Canada, Surface Policy Planning and Urban Programs, Canadian Air Transport Administration, and Transportation Development Centre as part of their program to improve national transportation system accessibility for travellers with special needs.

Transferring passengers who experience difficulties walking from one area of a transportation terminal to another presents an increasing problem. At present one attendant must be assigned to escort each person in a wheelchair. The wheelchair is the only device an elderly, disabled or semi-ambulatory passenger is offered. Motorized vehicles in Toronto's air terminals can transport larger number of passengers at one time; however, high steps and small bench seats do not address the requirements of wheelchair passengers, the elderly or semi-ambulatory.

As a result, an initial development, described in TP 3796 E "Travellers with Special Needs, Modular Transfer Platform Design Concept", by Uwe Rutenberg, Les Designers Douglas Ball Inc., November 1982, was presented.

After a review by the Transportation Development Centre, Air Canada and VIA Rail Canada Inc., the platform design was further developed, under a new contract, by building and testing prototypes. At the beginning of this phase, the original concept was evaluated and the separate motor unit found to create some difficulties in terms of operator handling, stability and friction of the drive wheel. A decision was made to incorporate the drive unit into the platform itself.

The motorized version has an off-center drive wheel arrangement at the front, with the driver standing beside it, providing traction for the drive wheel. Its operation is restricted to authorized personnel.

The non-motorized platform is shorter, has two swivel front casters and two fixed rear casters and is intended for the use in public and restricted areas of a terminal. All platforms have an extra-wide folding seat, a handrail for manual pushing and a ramp for wheelchair access which is in a vertical position when not in use. The platforms can be linked by a unique mechanism which, with the curvature at the ends of the platforms and a crosswise linkage system, keeps the turning radius very small.

Testing of three platforms, one motorized, two non-motorized, was successfully performed at Dorval Airport in early June 1984 to evaluate ergonomic factors for operators and passengers and collect 'real-life' information on system features and mechanical properties. Each platform was tested as a single unit and in a linked-up position. Four volunteer passengers simulated arrival and departure procedures; two 'real' passengers

used the platform on their way to the aircraft. Five volunteer operators from Air Canada performed most of the driving tasks, according to their schedule limits. A short training and introduction and some five minutes of driver training were enough to familiarize the operator with all the functions.

A motorized platform with a test subject was successfully driven from the entrance through a door at security, along an approximately 300 m long corridor to the waiting lounges, down the loading bridges and up to the aircraft door.

The non-motorized platform was used in the public area by accompanying relatives of the test subjects, and in the restricted area linked up to the motorized unit by a carrier agent. Seating comfort, access, leg room, safety and appearance were considered by the test subjects to be much superior to being in a wheelchair. Manual pushing was felt to be more difficult than that for a wheelchair.

Both operator and passenger subjects were generally enthusiastic regarding the use of the transfer vehicle. Reserved comments were made by some Management representatives who had pre-conceived ideas of their own, but others welcomed the vehicle's potential to increase service not only for the mobility disadvantaged, but also for all travellers faced with long walking distances.

Although function, appearance and handling were positively received, some refinements are necessary to improve on the performance. Brakes on the motorized platform, a finer tread on the drive wheel, central handle for the seat position and a restraining cord for the wheelchair should be implemented in a Mark II version. If the need for a larger capacity supply is required, there is room for another one or two batteries.

Results of the comprehensive test scenario at Dorval Airport indicated that the transfer vehicle would decrease the physical load of airline attendants presently assigned to transfer duties and increase efficiency in passenger handling, while providing disabled and elderly passengers with comfortable, psychologically acceptable transfer service.

Further tests by carriers for a longer period of time are recommended with improved Mark II prototypes to evaluate in-depth feedback from the carrier and actual passengers and to determine power supply requirements.

SOMMAIRE

En 1982, une proposition spontanée avait été adressée à Transport Canada, faisant état de l'insuffisance dans les gares, terminus et aérogares du Canada, d'aménagements destinés aux personnes âgées et aux handicapés qui se déplacent en nombre de plus en plus grand. Elle soumettait un projet qui, parce qu'il cadrait avec le programme visant à relever l'accessibilité des personnes ayant des besoins spéciaux au réseau national des transports, a été commandité par le ministère des Approvisionnements et services, la Direction générale, politique de surface-planification et programmes urbains, l'Administration canadienne des transports aériens et le Centre de développement des transports, ces deux derniers faisant partie de Transports Canada.

On sait combine il est difficile pour certaines voyageurs de se déplacer à l'intérieur d'une installation terminale un peu vaste. La pratique actuelle veut que des préposés assistent les personnes en fauteuil roulant, ce dernier demeurant encore le seul moyen mis à la disposition des personnes à mobilité réduite. A l'intérieur des aérogares de Toronto, circulent des véhicules motorisés pour le transport de plusieurs personnes à la fois, mais ni l'emmarchement, ni les sièges ne sont de nature à faciliter le déplacement des personnes âgées, de celles en fauteuil roulant ou encore de celles ayant de la difficulté à se mouvoir.

C'était pour corriger cette situation qu'un premier projet avait été proposé en novembre 1982 par Uwe Rutenberg de la maison Les Designers Douglas Ball Inc., projet portant le numéro TP3796E et intitulé "Travellers with Special Needs: Modular Transfer Platform - Design Concept".

Le centre de développement des transports, Air Canada et VIA Rail Canada ont examiné ce projet de près et préconisé qu'un nouveau contrat soit conclu pour la réalisation et l'essai de prototypes, en vue de perfectionner le véhicule en question. C'est durant cette phase que la décision a été prise d'intégrer le moteur à la plate-forme motrice, au lieu de constituer un module séparé comme dans le projet d'origine. Les raisons évoquées ont été les difficultés à manoeuvrer le module moteur, son instabilité et la mauvaise adhérence de la roue motrice.

Le moteur du nouveau modèle est maintenant placé à l'avant en position excentrée pour réduire l'encombrement du poste de conduite.

La plate-forme non motorisée, plus courte, comporte deux roulettes orientables à l'avant et deux fixes à l'arrière; elle peut circuler dans les zones publique et réglementée de l'aérogare, contrairement à la plate-forme motorisée qui ne doit circuler que dans la zone réglementée. Toutes les plates-formes ont un siège pliant très large, surmonté d'une barre horizontale pour pousser, et un abattant servant de rampe d'accès pour un fauteuil roulant. Un attelage à bielles croisées et des extrémités de plate-forme courbes donnent à l'ensemble un rayon de braquage très court.

Des essais ergonomiques couronnés de succès ont eu lieu au début de juin 1984 à l'aéroport de Dorval avec une plate-forme motrice et deux non motorisées, au cours de ces essais, données précieuses ont pu être recueillies sur le comportement réel du système et sur ses caractéristiques mécaniques. Chaque plate-forme a été essayée, d'abord seule, puis attelée. Quatre volontaires ont simulé la procédure d'arrivée et de départ, tandis que deux voyageurs se sont servis de la plate-forme pour se rendre jusqu'à l'avion. Cinq volontaires d'Air Canada ont assuré la conduite du véhicule, selon les possibilités de leur horaire de travail. Il ne leur a falllu qu'une très brève prise de contact de cinq minutes de formation pour se familiariser avec la manoeuvre du véhicule.

Une plate-forme motorisée occupée par un volontaire a été essayée avec succès dans la zone réglementée, depuis la porte d'accès jusqu'à la porte de l'avion, après avoir parcouru les quelque 300 m de corridor menant aux salles d'attente et aux ponts d'embarquement.

La version non motorisée a été essayée dans la zone publique, poussée par les accompagnateurs, puis dans la zone réglementée après qu'elle eut été attelée et prise en charge par un préposé. Les volontaires ont trouvé que les caractéristiques du véhicule (confort assis, accessibilité, dégagement intérieur, sentiment de sécurité et esthétique) constituaient une nette amélioration par rapport aux fauteuils roulants, mais que, par contre, il fallait plus d'efforts pour le pousser.

L'accueil réservé par le conducteur et les passagers a été généralement trés favorable. Toutefois, certains cadres ont formulé quelques réserves alors que d'autres ont apprécié la possibilité qu'offre ce véhicule d'améliorer la qualité du service non seulement aux personnes à mobilité réduite, mais aussi à tout voyageur appréhendant de parcourir de grandes distances à pied.

Le fonctionnement, l'apparence et la manoeuvre du véhicule ont été trouvés très acceptables, bien que celui-ci nécessite encore certaines mises au point, et des perfectionnements comme: freins pour la version motorisée, roue motrice assurant une meilleure traction, poignée centrale devant la banquette et immobilisation pour le fauteuil roulant, le tout devant équiper le deuxième prototype. Eventuellement, une batterie plus puissante, pourrait être utilisée un ou deux éléments supplémentaires pouvant être logés à bord.

Les essais complets effectués à Dorval ont montré que ce véhicule permet d'alléger l'effort physique requis des préposés, d'améliorer la qualité du traitement des passagers et de mettre à la disposition des personnes âgées et des handicapés un mode de transport intérieur à la fois confortable et psychologiquement acceptable par elles.

Des essais plus poussés seront cependant nécessaires avec le deuxième prototype, afin de lui faire profiter des commentaires émanant des passagers et des préposés et de déterminer la puissance d'alimentation nécessaire.

ACKNOWLEGEMENTS

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We would especially like to thank Messrs Frank Hare and Robert Corkett, of Transport Canada and Roger Champagne and Brian Wright of Air Canada.

Special thanks go to Dr. Ruth Heron of the Transportation Development Centre for providing us with valuable ergonomic input during all development phases.

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1.0 INTRODUCTION

An unsolicited proposal to study transfer facilities for special need travellers resulted in a DSS contract awarded to Les Designers Douglas Ball Inc. in July 1981 to perform the work for the Transportation Development Centre (TDC) of Transport Canada. The initial phase of the work included findings documented in report TP 3796 E "Travellers with Special Needs, Modular Transfer Platform Design Concept" by Uwe Rutenberg, Les Designers Douglas Ball Inc., November 1982. Interest in the further development of the concept, at least to the prototype construction and field evaluation stage, was expressed by Air Canada and VIA Rail Canada Inc., and this development was generally supported by Canadian Air Transport Administration and TDC steering committee members.

Air Canada perceived the vehicle as a useful tool in transferring special-handling passengers from the check-in counter to the boarding gate. Accordingly, Air Canada offered assistance in demonstrating and evaluating a prototype unit. VIA Rail Canada Inc. had a slightly different use in mind. This company saw a version of the motorized platform for handling both people and baggage on train platforms where great distances are travelled, as well as perhaps for handling food supplies. Thus, VIA expressed interest in testing a working prototype. This project addresses the prototype development and testing phase.

1.1 Objectives

The general objective was to improve access to our national transportation system for that part of the Canadian population who require special service.

The specific objective was to prepare drawings and specifications, build prototypes, and carry out the testing and evaluation of a modular transfer platform for the transport of mobility-disadvantaged and other handicapped persons within air, rail or ferry terminal complexes.

2.0 DESIGN OF PLATFORMS

2.1 Motorized

The original concept as described in TP 3796 E consisted of one small separate motor unit, and one platform type only. Each platform was to be of the same size, to be accessible to a wheelchair and/or to accommodate an ambulatory or semi-ambulatory passenger on an extra wide foldable seat. (Fig. 1 and Fig. 2)

After analyzing this concept with Air Canada, Transport Canada and VIA Rail Canada officials it was felt that incorporating the motor unit into one platform would facilitate handling by the operators and provide better driving capabilities for the motorized platform.

The first functional, wooden platforms, containing a motor unit and two 12 volt gel-cell batteries were built in the fall of 1983 and pre-evaluated on paved roads and parking lots. One motorized and two non-motorized units were linked together, and were driven up and down inclines of approximately 1:12. (Fig. 3)

Power and friction were found to be adequate with power units bought off the shelf from Everest & Jennings Canada Limited; the linking mechanism was determined through a number of tests with wheelchair users.

The second phase began with the preparation of preliminary technical drawings to determine building and fitting of all components. Most of the components had to be custom built, machined and fitted. A decision was taken during this process to eliminate a ramp on one side. This made access easier, eliminated walking over the ramp, and reduced handling of the ramp by the operator.

The off-center position of the drive wheel allowed for two other major improvements: it gave the driver standing room right beside the motor and because of the driver's weight, increased friction on the driving wheel. Driving the motorized platform facing or with back to the seated passenger was considered, and the tiller was designed to adjust back or forth for either driving position. Later in the test, this driver variation was found to be useful in adjusting for different arm lengths when standing and driving. Two driver perches were designed and built for the same purpose. They allowed the driver to position him/herself between the two supports, leaning against one, bracing the feet against the floor, and using the second support to stabilize with the free hand in curves.

To drive the platform, a trigger on the end of the tiller is pulled by the index finger to increase or decrease speed gradually. Acceleration and deceleration are very smooth and are regulated by a control box.

The tiller direction is positioned in line with the drive wheel and allows for direct driving.

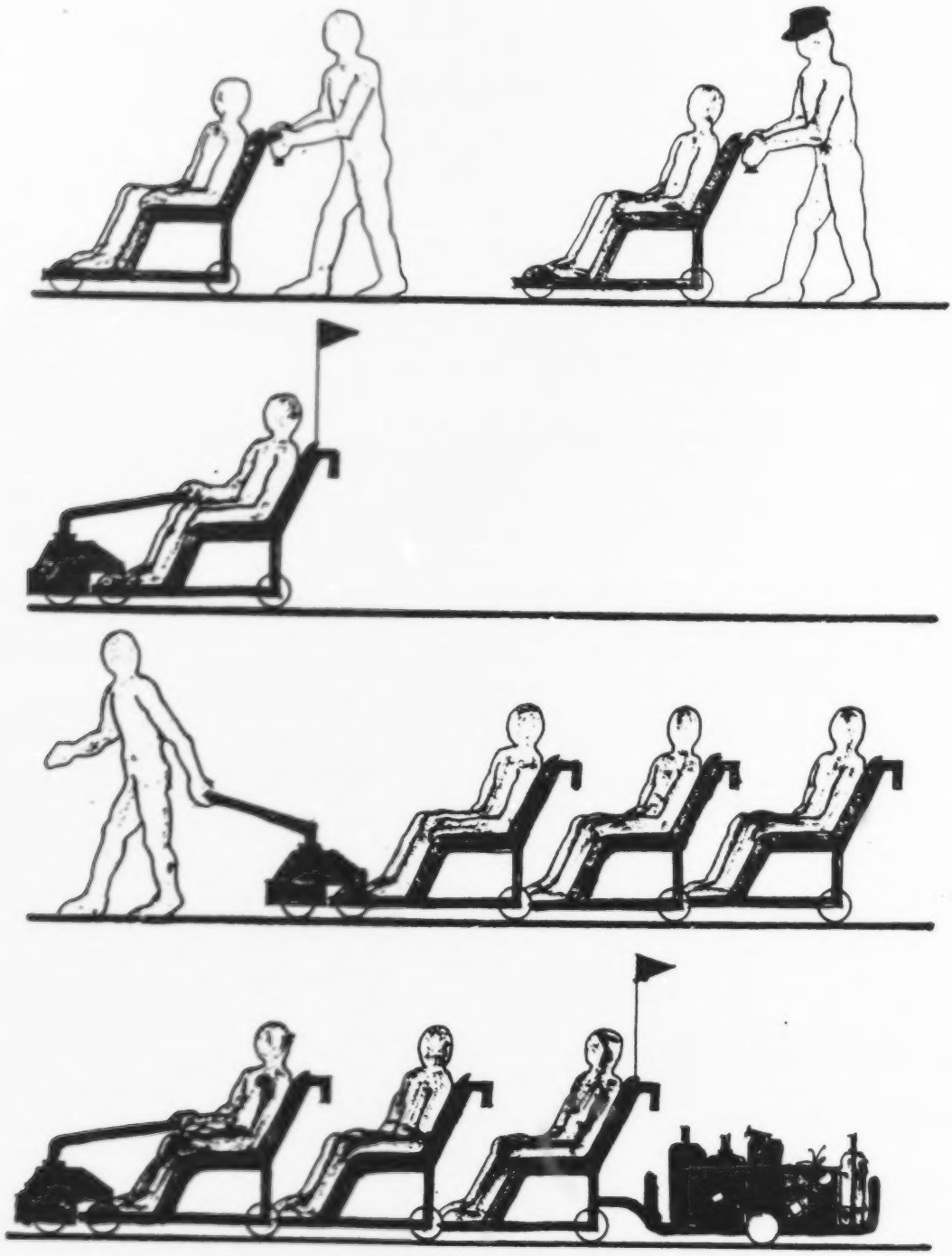
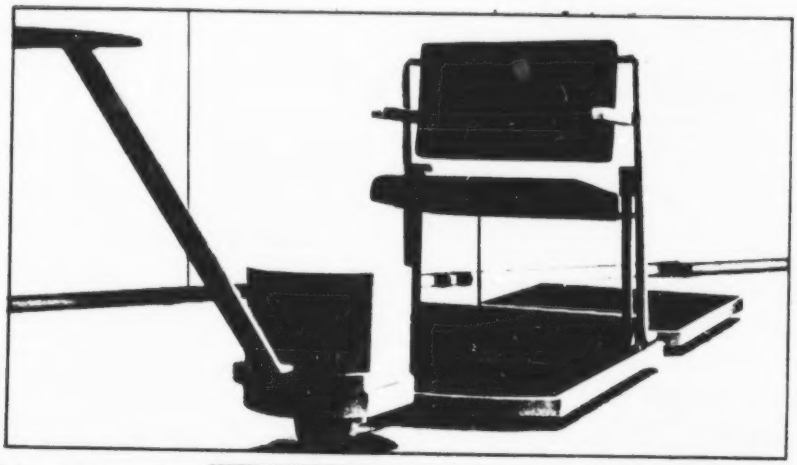
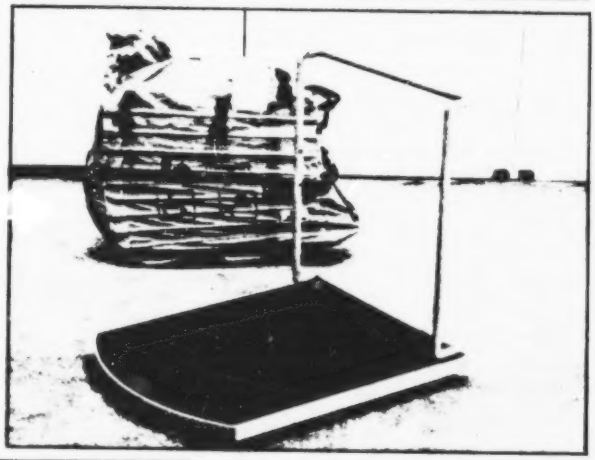


Fig. 1 Original Concept

Fig. 2 Full scale mock-ups



A handrail with an extra wide seat can be attached onto this platform. The seat is stored in a vertical position, when a wheelchair user is getting onto the platform. When used by ambulatory and semi-ambulatory people, seat and armrests fold down.



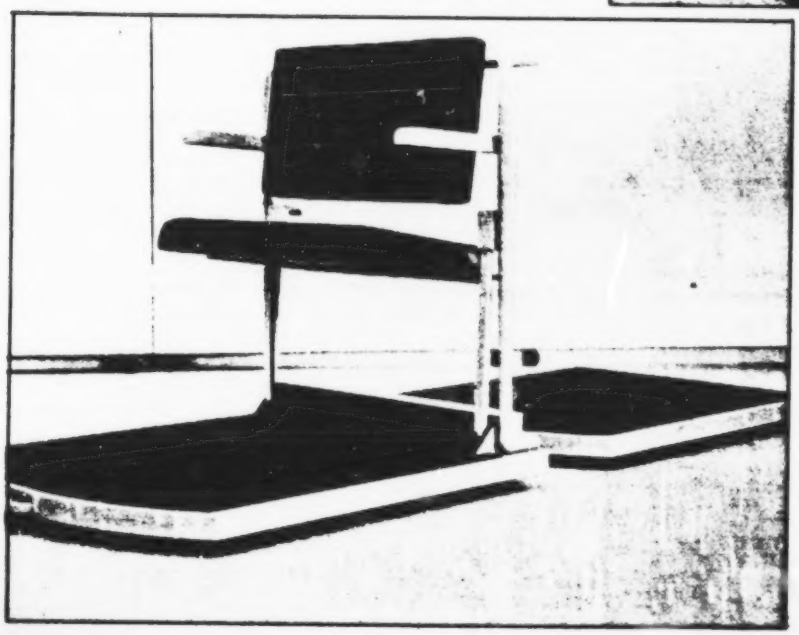
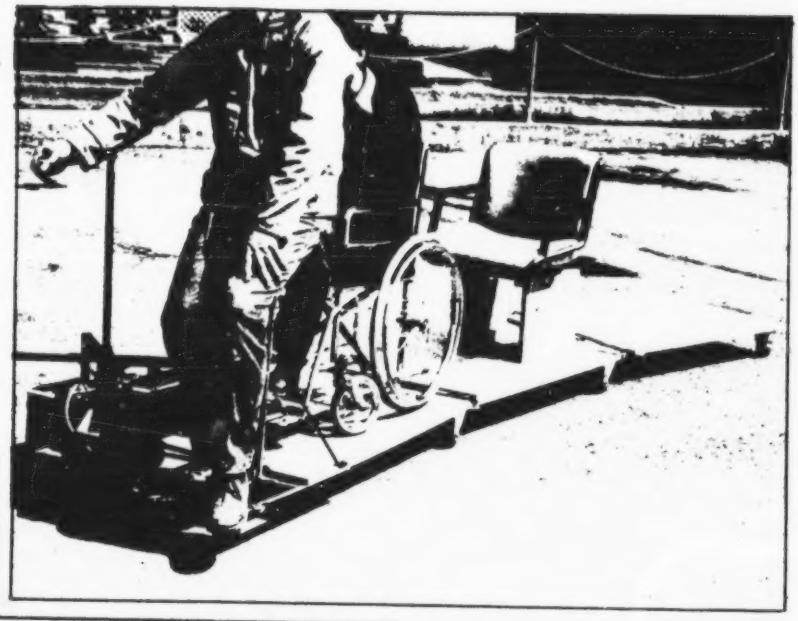
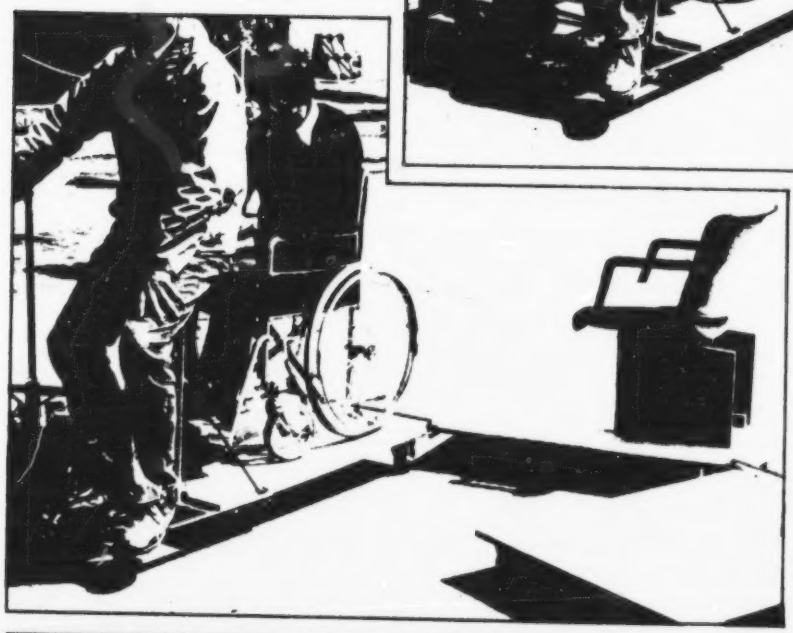


Fig. 3 The first functional wooden platforms are assessed





The operator can either sit beside the motor with the user behind, or turn the unit around to drive, sitting behind the user. If more people are to be transported, two more platforms are linked to the motor platform.

The seat consists of a frame bolted to the floor which incorporates a handlebar on the rear end of the platform for pushing. Seat, back and armrest all fold into a storage position, slightly angled toward the rear of the platform. This feature allows the large wheels of a wheelchair to rest against the seat frame and creates approximately 120 mm (5") extra room for the wheelchair.

When used as a bench, the seat is brought into the forward position by locking plates on either side. The seat folds down and rests on a hook off each armrest. Seat, back and armrest are made of tubular framing, with additional metal mesh welded into the frame of the seat and back for a light, transparent appearance. The ramp is built in the same way; that is, a tubular frame surrounding sheet metal mesh. It locks into its stored position by a small lever, which swings down. The ramp, in its stored position, acts as a protective barrier for the passenger and his/her hand luggage. The inclination of the ramp, when in use, is 1:4.

The dimensions of the prototype are:

Length; 1,74 m - width; 0,84 m - platform over floor height 0,15 m. The front and rear of the platform are curved, primarily for the linking mechanisms, but also to slide off walls, columns, etc. more easily.

2.2 Non-Motorized

The non-motorized platform is essentially the same as the motorized, except for the motor column and the driver space. It is therefore shorter, but has seat, ramp and handlebar. This unit has two swivel casters on the front and two fixed casters on the rear. All platform floors are covered with ribbed vinyl to prevent wheelchair slippage and to ensure safe footing for ambulatory passengers. These platforms can also be converted into baggage units, by replacing the seat unit with a baggage railing.

The linking mechanism between all platforms consists of two steel tie-rods, each crossing from one corner (e.g. left) of one platform to the opposite corner of the next (e.g. right). This arrangement allows for a uniquely small turning radius and increased manoeuverability, a feature that is a premium in any terminal.

The colours of the prototype were selected to give these platforms a modern, light appearance, to detract from the typical look of wheelchairs, handicapped equipment or medical products. The frame, floormat and the motor column are light grey with a small red bumper clearly defining the periphery of each platform. This is especially important for visually impaired passengers, when stepping onto the platform. The seat units and the ramps are spray-painted a copen blue.

3.0 INTENDED USE

3.1 Motorized

There is a fundamental difference in the use of the motorized and non-motorized platform.

The motorized platform should be used only by authorized and trained personnel in both the public and the passenger-only areas.

The motorized platform can be used alone or can pull one or more non-motorized units. It can carry either one wheelchair passenger (one who cannot easily switch to a seat), one obese passenger, a mother with a non-walking child, or an elderly passenger not able to walk long distances. Passengers can be picked up at any location in the terminal; the entrance, the information booth, the ticket counter, the TC counter, or wherever they are asked to wait. They would then be driven by authorized personnel through customs, immigration, and security up to the waiting lounge or directly, over the bridge, to the door of the aircraft, providing the dimensions of these different points are compatible with those of the vehicle. Tests to find out where barriers existed were performed at Dorval Airport and will be discussed under section "TESTING".

There are several reasons for the use of such a vehicle:

a) For the carrier to provide improved service to and from carrier gates,

b) To reduce personnel assigned to passenger handling which, at the moment, is on a one-to-one basis for every special-need passenger,

c) To offer a stigma-free transfer aid for passengers unable to walk long distances and who do not wish to identify themselves with a wheel-chair.

3.2 Non-Motorized

The use of the non-motorized platform is two-fold: being pushed manually or trailed by a motorized unit.

When used alone, it is meant for the public area by passengers who arrive with friends, companions or relatives able to push and manoeuver the unit. Often arriving with time to spare, these passengers have, at the moment, two choices; either to wait in a lounge area or be wheeled around in a wheelchair. Many resist the latter because they feel that they are not 'handicapped', something the use of the wheelchair suggests. However, many would like to use the terminal for sightseeing, visiting stores and restaurants, arranging for insurance, changing currency, etc.

The transfer platform is designed to perform these tasks. The passenger is provided with a wider, comfortable seat, armrest and leg room to stretch out, along with place to store crutches or canes. The platform is

also equipped with a ramp for wheelchair access. There is room for hand luggage underneath the seat. The platform could be pushed by friends up to the restricted area, the carrier agent then taking over, linking the platform to a motorized unit and driving the passenger through security, immigration and/or customs. If more than one passenger needed assistance, the agent could simply link more platforms to a motorized unit and drive to waiting lounge or the aricraft door directly for pre-boarding.

3.3 Train

The "Train" refers to one motorized unit pulling one or more non-motorized platforms. Two 12 volt batteries probably cannot supply sufficient power for a prolonged time, but up to two more batteries can be added to increase this supply.

On a regular long distance route between security and the gate (often between 200 - 400 m), a train offers substantial savings in personnel cost. In a typical set-up with one motorized and two non-motorized units, up to six semi-ambulatory persons (not wheelchair users) can be transported by only one driver. On the way back, even if there were no passengers, crew members would probably welcome a break from walking, especially after having spent six or eight hours on their feet. Even regular passengers would welcome a ride after a long tiring flight.

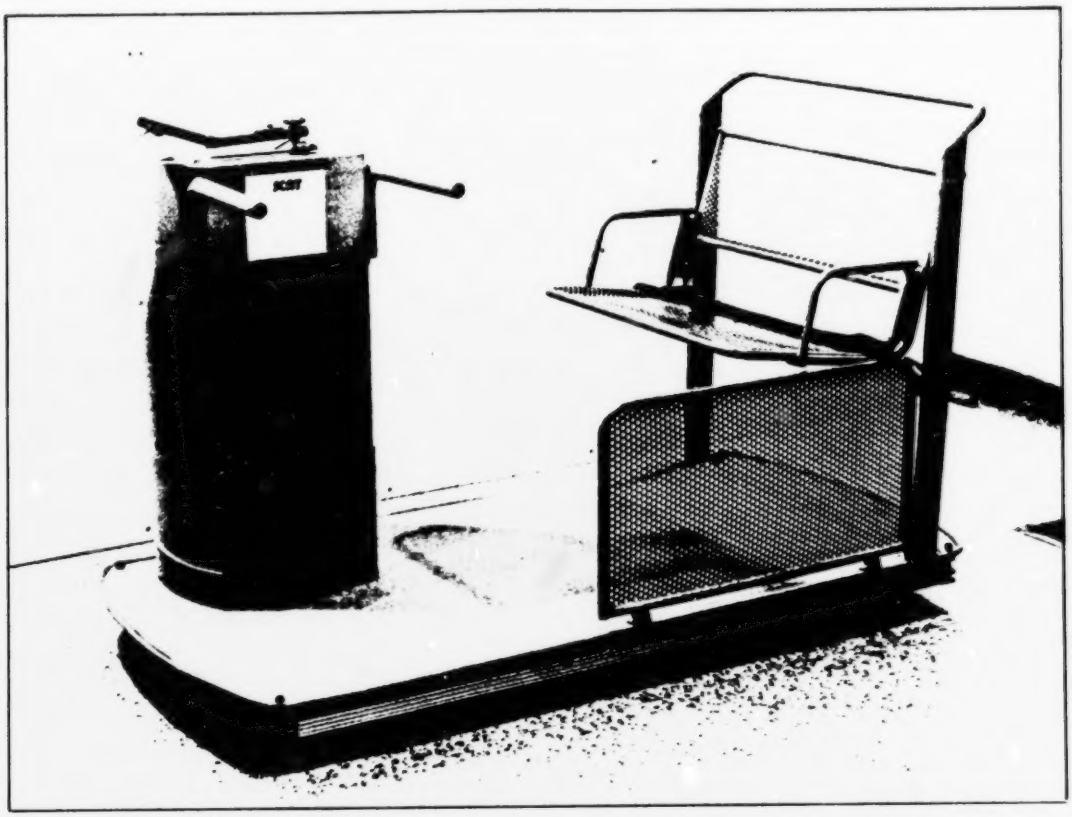


Fig. 4 Motorized platform.

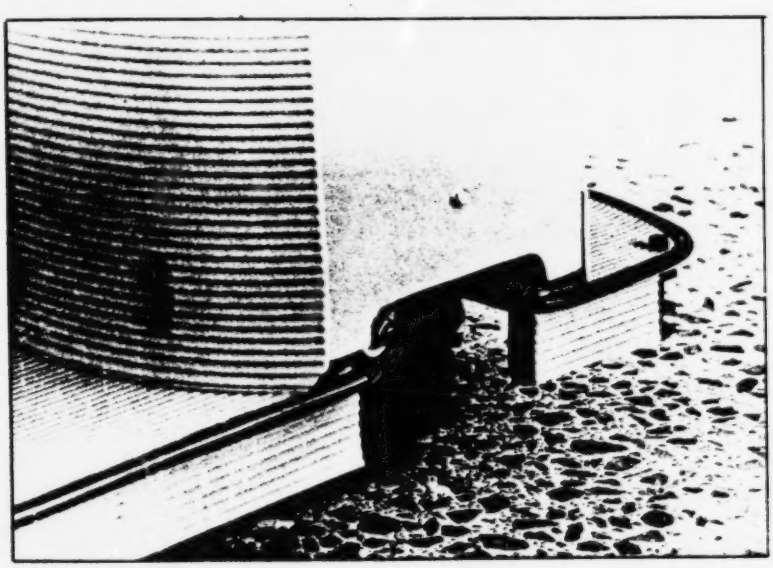


Fig. 5 Off-center drive wheel.

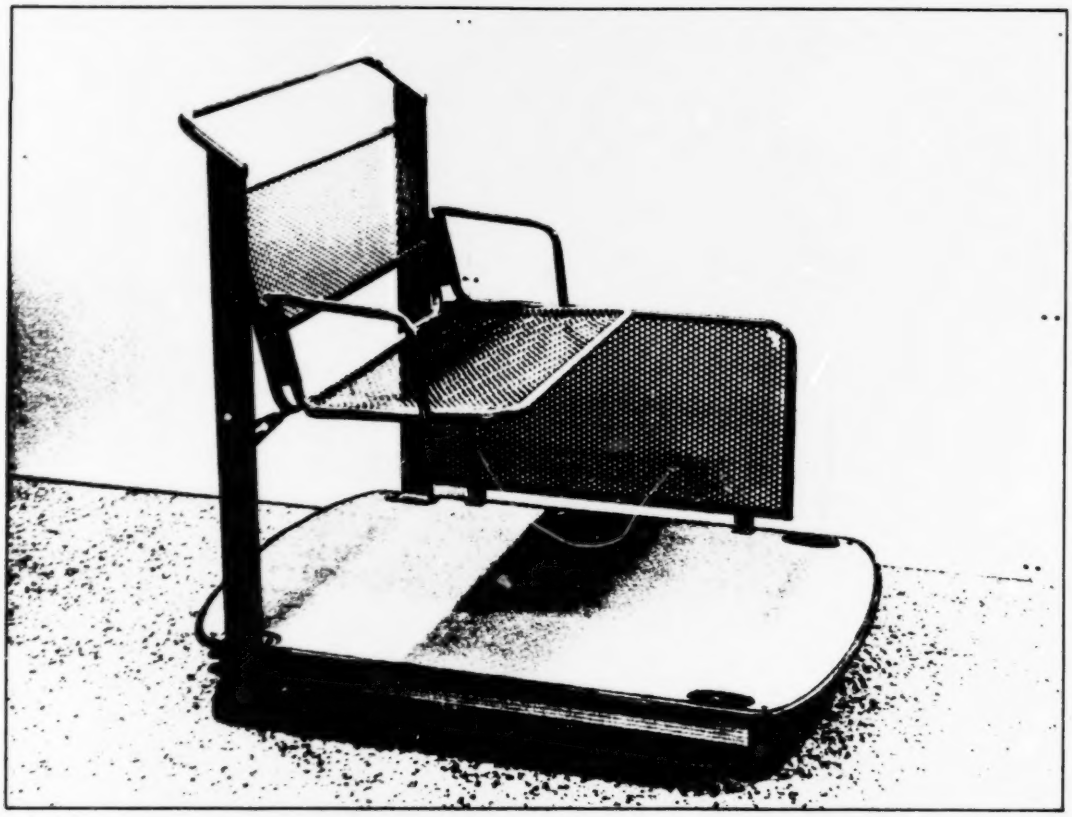


Fig. 6 Non-motorized platform.

Fig. 7 Handrail for manual pushing.

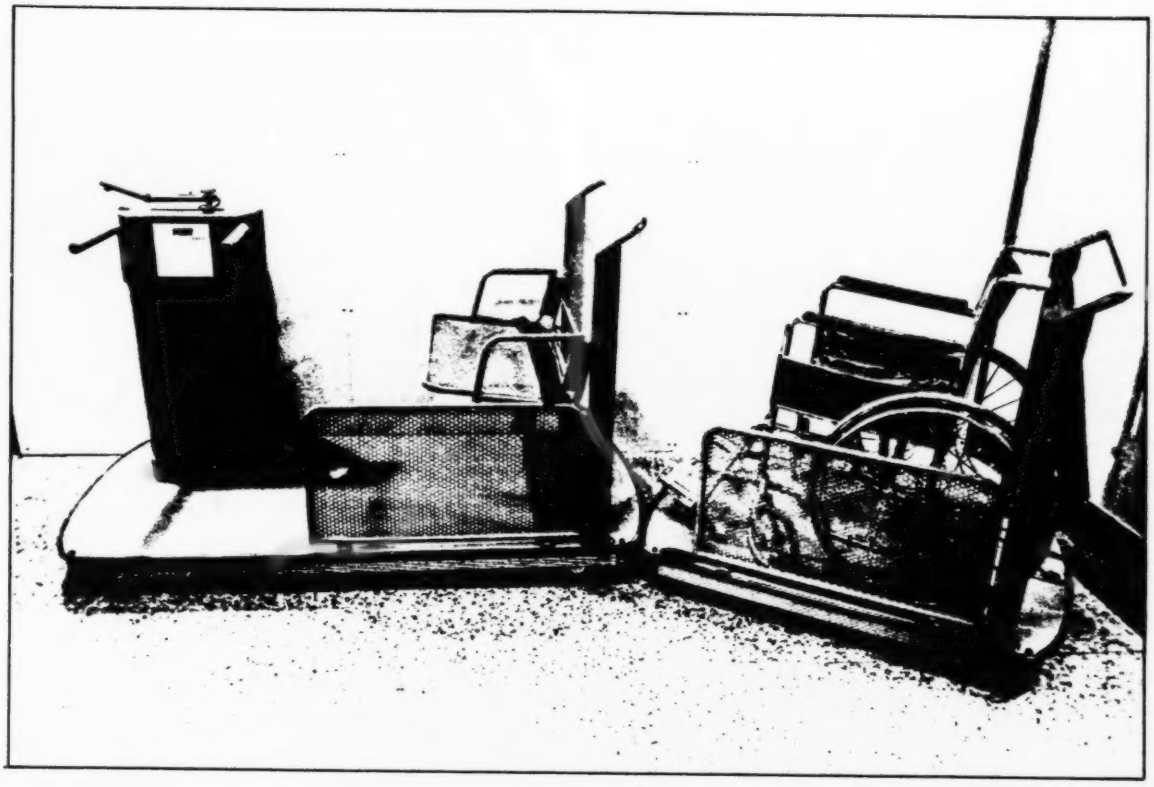


Fig. 8 Platforms linked as "train".

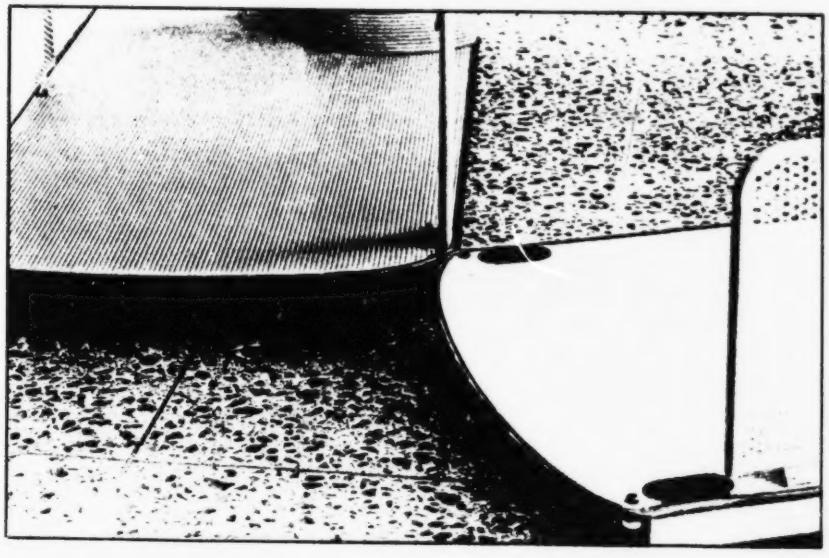


Fig. 9 Innovative linking mechanism between platforms.

4.0 TESTING

Testing of the prototypes was done in the beginning of June 1984 at Dorval Airport.

The purpose was:

a) to evaluate ergonomic operator/driver handling of the vehicle and the passenger,

b) to evaluate passenger reaction,

c) to analyze how the vehicle would perform at this specific airport, fitting into existing procedures,

d) to analyze mechanical performance.

4.1 Test Procedures

The testing was done during one week, and a typical scenario was set up as follows:

The designers met in the morning with both the passenger volunteer and an Air Canada operator. Each was given an introduction to the concept, and to the use and operation of the vehicle. The operator/driver could usually handle the vehicle after 3 to 5 minutes of driving. According to the disability of the volunteer passenger (wheelchair user, crutches, mother with small child), the operator/driver was then shown how to operate the ramp and the seat, and how to manipulate the wheelchair.

The 'passenger' was driven from the entrance, ticket counter or information counter to domestic gates 1 to 5, which are 100 m to 300 m from the entrance. To bypass security a separate door was used, which was approximately 10 cm (4") wider than the vehicle with enough manoeuvering space on each side for turning.

The security check was done manually, while the passenger stayed on the vehicle. The corridor to gate 5 is more than wide enough to easily turn the vehicle with two trailing platforms. Turning radius is 2.70 m (9'0"). The vehicle passed without any problem through all openings at the interior lounge area, through all doors to the bridges. It was also driven up (in two cases) to the aircraft door with very steep bridge angles, 1:12 and 1:18, and carpeted flooring. This was done with the motorized platform only, no trailing platforms. All corners on the bridge were easily negotiated up and down again. These tests were recorded with a video camera while comments from the passenger and the operator were taken down on tape. All typical procedures and manoeuvers were also recorded.

Monday June 4, 1984

The vehicle was introduced to Air Canada management and one operator. The volunteer passenger was a wheelchair user in his 50's, approximately 73 kg (160 lbs). He was able to wheel himself manually as his upper body was of regular strength. He normally travels in his own chair and switches to a narrow washington chair to board the aircraft.

The passenger was wheeled onto a non-motorized platform by the driver who just operated the ramp by releasing the lever, and then wheeled the chair on backwards. The driver positioned himself on the platform, tipped the wheelchair back, and pulled the chair toward him. The driver's height was approximately 1.70 m (5'6") and he had to stretch his arms to the wheelchair handles to reach them. He avoided standing on the ramp when wheeling the chair up because there was an initial 2 cm (3/4") of tubing frame on the ramp that had to be overcome. It required extra pulling momentum. Access ease also depends on the wheelchair's tire type. In this case, they were soft, airfilled tires with low pressure and they were more difficult to wheel on than hard tires.

It took the driver two or three tries to find out how best to back the chair up against the platform seat; manoeuvering space on the platform was good. At no time was the wheelchair in any danger of rolling off or being off-balance. Bending to pick up the ramp and locking it into position was done, in this instance, with the legs stretched, not by using the knees. The driver's perch seemed a little bit too high for this driver's height.
A second driver was introduced to the vehicle on the same day. This second driver was about 1.85 m (6'0") tall and found the driver's perch perfect for his size. He also used the two driver's perches for hand support to get into the driver position, and used the one in front of him as a handle, while driving. The position of the tiller was adjusted to his longer arm length. He found it to be a comfortable reach, even when making a sharp turn. Both drivers found the trigger adequate but would like to see an improved and more visible control.

The second driver wheeled the same chair onto the platform in a different manner. He approached the ramp with the front of the wheelchair, tipped it back and pushed it. This required more physical strength in his arms, back and legs. He also lifted the chair back against the seat structure. He was around 30 or 35 years old, and we believe his method would change if he had to handle some 50 wheelchairs per day.

The wheelchair passenger had a very positive reaction to the vehicle. He was not intimidated by being tipped back, he felt secure after setting his brakes and his chair did not move around. He felt the vehicle speed was comfortable and would not like to see it go any faster.

Safety and comfort were a much greater concern to him than speed. Going over joints in the corridor floor did not present any problems, providing they were not larger than 2 cm (3/4") in width. If there were differences in height, this would result in a little bump, something that has to be corrected by the use of softer, semi-pneumatic tires.

Tuesday June 5, 1984

A woman was assigned by Air Canada as an operator/driver. She was in her late 30's, approximately 1.60 m (5'3"), and of average weight.

The subject passengers were a young lady with a nine month old child and an elderly couple. The gentleman was using a crutch and was not able to walk more than a few feet without assistance. The wife was able-bodied and could easily push a non-motorized platform.

The purpose of this day was two-fold: first, to analyze the motorized platform, as an operator drove mother and child to gate 5 (longest distance) up to the aircraft, and then returned empty of passengers; second, to evaluate how a semi-ambulatory passenger, with a companion, could use the non-motorized platform in a public area.

After the usual introduction, the driver helped the volunteers onto the motorized platform (the non-ramp side). The mother used the handrail of the seat structure for support, as well as the armrest. Mother and child both sat on the bench and utilized the seat belt. The mother was in her late 20's, approximately 1.65 m (5'4") and weighed about 70.5 kg (155 lbs). She was strongly built, and both mother and child took up the complete seat.

The driver then drove to the security gate, passing a special door without difficulty, and drove up the long corridor to gate 5. The mother found the seating height and back angle comfortable. She wore heavy clothing and could not, therefore, comment on whether the seat pad would be required for long stretches. At the waiting lounge of gate 5, debarking was analyzed. The driver stopped the vehicle to allow room to step down from the platform. The mother released the seat belt, took her child in one arm while still sitting, and used her free hand to hold onto the driver perch in front of her, as a support to pull herself up and out. The small 14 cm (5 1/2") step from the platform to the floor was easy to negotiate and the red bumper was welcomed as a visual indication of the edge of the vehicle.

Next mother and child again sat on the platform and the vehicle was driven down the bridge to the aircraft. Problems arose with joints in the bridge floor, covered with aluminum profiles 8 cm (3") wide. Although usually covered with carpeting, they were bared on this day and posed a height variation in the flooring. The drive wheel sometimes slipped on these profiles when the driver stopped right over them. Driving down, turning around and going back up again presented no problems in terms of traction, power or manoeuverability. The speed was comfortable for the driver and the passenger, and even the child seemed to enjoy the ride.

The second part of the testing was done with the elderly couple, using a non-motorized platform in the public area. The man, using one crutch, was helped onto the seat by his wife. Both were in their 60's. He was around 1.85 m (6'0") tall, she approximately 1.65 m (5'4").

When stepping onto the platform, the male passenger supported himself with his free hand on the handrail of the seat structure. After sitting, he positioned his crutch on the free side of the seat. His wife then wheeled the platform throughout the public area, using elevators with no difficulty. Entrances to restaurants and shops were found easy to negotiate, but access to the washroom was limited for lack of menoeuvering space. As a final manoeuver, the woman pushed the platform up to the security gate, at which point it would have been linked up to a motorized unit driven by carrier personnel.

The passenger expressed satisfaction with the wide, comfortable seat which allowed him to move in various positions. He also felt the seat height of the platform was more convenient than a wheelchair. The wife felt it was slightly heavier pushing the platform than a wheelchair, but preferred the vehicle's appearance. She obviously expressed pleasure that her husband felt more comfortable as well.

Wednesday June 6, 1984

Two project officers from the TDC arrived for a hands-on evaluation.

One began the test by accessing the motorized platform with her wheelchair, and was then driven to domestic gate number 5, which has one of the steepest btidges. Joints on this bridge are between 5 and 8 cm (2" and 3") wide, covered by an aluminum profile, presenting a height difference of up to 8 cm (3"). This created the same problem for the drive wheel as in an earlier test run. The body of the platform touches the joint as it is passed over by the drive wheel, and the drive wheel itself slips into the joint on occasion. Going over the joint, the TDC passenger felt it was necessary to dampen the shock. The steep, downward angle of the bridge brought out other areas which also have to be improved. The vehicle needs a brake to come to a full stop. The platform needs a restraint system to prevent the wheelchair from rolling. The steep angle upward was no problem for the powertrain, but it seemed to be the limit in terms of incline on a carpeted surface. The inclination on the bridge was approximately 1:14.

The TDC passenger then transferred from the wheelchair to a seat on the non-motorized platform, using the handlebars for support.

The other TDC officer was instructed in the driving of the vehicle; she could easily handle two linked platforms within a few minutes of driving.

Thursday June 7, 1984

This day was used to gather public opinion and to assist real passengers.

The platform was driven through the public area. Passengers looked rather enviously at a vehicle which could alleviate long distance walking. Comments like "I wish I could use this!" to "Who is providing this service now?" were frequent. There was no connection to 'handicapped' or 'impaired' persons made by the public. It seemed a logical service improvement. A very positive reaction was also heard from crew members. They were constantly asking if it could be used to take them back and forth to the aricraft.

During the drive through the public area, the platform was offered to assist elderly people. All gave a very positive reaction. "It sure beats walking" was one of the most popular comments. Since the speed is approximately the same as walking, the vehicle was not seen as a threat, but as a comfortable and safe alternative.

Later in the day, a real passenger was picked up at the entrance. He had originally been offered a wheelchair because of his ambulatory limitations. He was transferred from the wheelchair to the motorized platform, helped by a carrier driver/operator. He was driven to gate number 2, passing security through the special door. He was checked manually by a security agent. Once the aircraft was ready for boarding, he was driven down the bridge, with a typical incline of about 1:8 and only small joints to overcome, to the aircraft door. The vehicle was parked next to the wall, with the ramp closed, in order to allow the passenger to step off the opposite side. He was helped on board by a stewardess and slowly walked to his seat, where he commented; "this is certainly better than a wheelchair!"

Further testing was conducted during the day on mechanical performance as well as power source capability. The vehicle was driven without a trailing unit back and forth three times to the domestic gates. Then, with one trailing platform, it was driven completely around the departure level twice with one passenger, and then twice more with two trailing platforms and three passengers. There was approximately 50% power left in the batteries after this test. Most of the power is consumed on the bridge inclines, on deep pile carpeting. This, of course, is offset by the fact that very little power is needed to drive down the bridges. Further testing would accurately indicate the compensation factor.

Friday June 8, 1984

The purpose this day was to find out how the vehicle would physically fit into this specific airport. No passengers were used, only an Air Canada driver/operator and the contractor. The motorized platform was first driven from the exterior ramp on the departure level, through the automatic doors. This created a small problem because the doors open toward the passenger.

Once the door opened, the vehicle passed easily over the mats, tiles and thresholds. It then made its way to the elevator near the security door. The motorized vehicle easily clears the elevator doors and can drive directly in lengthwise, with about 15 cm (6") to spare. Driving out again did create a small problem due to a difference of floor levels between the elevator and the corridor (about 8 cm - 3"). This is not a daily occurrence, however, merely faulty service. In the baggage area, the space in fromt of the elevator is fenced in on two sides and allows for an easy drive off as well as sufficient turning space. Retrieving baggage is not a problem as adequate space is provided between all carousels. The baggage claim exit offers 50 cm (20") clearance on either side of the vehicle. Driving through the automatic exit doors is much easier than entering, because they open outward. Outside, there is a direct taxi, bus or private car pick up.

For the next test, the vehicle was driven outside at ground level in order to simulate terminal access. All doors have ramps which lead to a level landing. Only one entrance was not accessible because of width - 75 cm (30"). Entrances do create a slight problem because of outward swinging doors; sliding doors would be more appropriate.

The vehicle was then driven through all Canadian customs and immigration check points and did not face any obstacles. The elevator normally used by passengers to arrive at this level was out of service and could not be tested. However, it was assumed that the motorized platform would fit lengthwise as in the other elevators. US immigration was not accessible since their aisles are about the same width as the vehicle (approximately 83 cm - 33") with no clearance. But we were told that they would make one aisle accessible, if needed. Customs clearing was not a problem; the vehicle drove right up to the counter.

Access to gates 15 to 23 could not be tested, since the elevators were out of service. Access to the corridors and the waiting lounge was no problem.

4.2 Test Results

Results showed a very positive reaction from the two groups who would actually use this vehicle: the passengers and the operators. Both groups felt it would improve passenger handling and service. To evaluate actual implementation into carrier procedure and policies, a longer in-depth test of use by the carriers will be necessary.

On the passenger side, the tests have shown a significant improvement in comfort, safety and recognition of needs. The fact that a passenger who has difficulty walking is offered a 'non-handicapped' product will probably increase its use for all passengers who, at the moment, refuse to be put in a wheelchair.

Surprisingly, we discovered that the highest percentage of wheelchair passengers represents people who have difficulty getting around, not those who are permanently wheelchair bound. Probably only 10% of passengers in wheelchairs are regular users.

The dual system of using the non-motorized platform in the public and restricted areas by companions and/or carrier personnel was felt to be effective in alleviating workload for carrier personnel.

Ambulatory volunteer passengers found it extremely easy to get onto the platforms, not just because of the low floor height, but also because of the tubular (steel) driver support bar and seat parts which they readily used for stabilization. The seats were found to be comfortable despite their metal construction, likely because their perforated nature renders them somewhat flexible. It was noted, though, that the mother and child fully occupied one seat, and that two people of average size would likely feel cramped if it were necessary for them to sit together for a long period. However, the platform was not conceived as a long-haul vehicle, but rather as one which would overcome distances difficult for the non- and semi-ambulatory; hence some compromise in seating comfort is necessary in order to keep the vehicle narrow enough to get through doors and into the elevators.

During the backward pull-on access mode, wheelchair subjects reported experiencing a feeling that the attendant had the chair well under control. Such confidence is well founded in fact since control is indeed greatest in this mode.

All volunteers spontaneously mentioned that such a vehicle would facilitate travel and transfer for them. But perhaps the greatest indication of this fact was manifested by the two actual passengers who, in wheelchairs because of temporary ambulation difficulties, had 'hitched' a ride on the vehicle during the testing period. Since it is possible for both ambulatory and wheelchair passengers to access the platforms at the end of the bridge, these individuals could have avoided use of a wheelchair altogether had a vehicle such as this been in service at the time.

However, some uneasiness was witnessed on the bridges where it became clear that additional restraining of the wheelchair is necessary. In addition, of course, wheelchair passengers can avail themselves of the 5 cm nylon webbing lap belt actually meant for seat passengers by simply passing it under the armrests of the chair.

On the driver/operator side, the ease in manoeuvering platforms, the capability of driving more than one passenger at a time, and improved driver comfort were positive factors.

Instructions regarding operation of the vehicle were readily understood. Although some operators tended to start up too quickly at first, causing the heavily treaded drive wheel to spin. Additionally, a tendency was noted for operators to begin the turn required after entering the door to Security too early; the correct strategy with this vehicle is to move right up to the door to overcome such difficulties.

The adjustability of the tiller, designed this way to allow the driver to face either forward or backward, proved serendipitously advantageous in another respect, namely, in that it could be adjusted to the length of the arm of the driver regardless of the direction of facing. This feature can be considered important in light of the fact that operators would be drawn from both male and female personnel and, therefore, would vary widely in body dimensions. However, an adjustment is required for the trigger movement which, because it does not work against a reference scale, does not correspond with sensation of vehicle speed. The trigger will be replaced, likely with a thumb-operated sliding switch on the top of the tiller.

Observations indicated that males tended to push the wheelchair forward up the ramp, while females tended to pull it up backward. The latter mode of accessing the platform is less strenuous than the former, since the small front revolving wheels of the chair are less able to overcome resistance on meeting the metal tubing lip of the ramp than are the large rear wheels. Moreover, the backward pull-on movement allows the attendant to tilt the chair so that the occupant's weight is directly over the wheel axles, thus reducing the physical load. Once the chair is on the platform, the attendant can easily manoeuver it into position by stepping backward onto the floor and working from behind the chair. Unloading is done by rotating the chair into ramp-facing position, tilting it backward, and moving forward down the ramp.

Some eye-hand coordination difficulty was experienced by subject operators in attempting to fold and unfold the seat because manipulation of the positioning plates on the prototype requires that both hands be used at the same time. The remedial measure will involve a connecting rod with a handle so that both plates can be moved simultaneously.

In general, problems experienced with the transfer vehicle by subject operators were few and readily solvable, and a common comment by these volunteers was to the effect that such a vehicle would provide an effective answer to difficulties they now encounter in transferring special need passengers. This was particularly true of the females who, although they are on the average smaller in stature and have less overall strength than males, are nevertheless usually assigned the task of escorting wheelchair passengers to and from the bridge. The physical load incurred in these cases is particularly heavy on the ramps, and it would not be surprising to see increases in the incidence of back, arm, and shoulder strain among these employees.

Technical questions which could not be answered at this time, but which must be addressed, relate to performance based on frequency of use, training, and vehicle cost.

Prolonged testing on a daily basis, monitored carefully, would reveal more details, especially in terms of procedure and policy.

5.0 IMPROVEMENTS

During this test the following technical and operational changes were felt necessary as improvements:

a) change drive wheel tread to prevent slipping on tiles and waxed surfaces,

b) change caster wheels from solid rubber to semi-pneumatic to absorb shocks, when driving over joints,

c) allow height adjustment for driver's perch,

d) change trigger on tiller arm to provide better sensory feedback in controlling speed increase/decrease,

e) improve linkage hook-up between platforms for easier manipulation,

f) provide central handle for changing seat positions (folding - unfolding),

g) provide restraint cord for wheelchair users to prevent movement,

h) install brake for both motorized and non-motorized platforms,

i) provide buzzer for driver, to alert fellow passengers of moving platform.

6.0 RECOMMENDATIONS

The implementation of the above listed improvements is recommended in a Mark II version before any further evaluation. Then additional testing should take place to evaluate 'fit-in' into the carrier system, and to receive more in-depth feedback from carrier personnel, management and actual passengers. Mechanical performance and recharge cycles have to be evaluated during these trials. In order to evaluate performance, maintenance and use, a pre-determined number of units should be tested by the carrier on a daily basis, for an extended period of time. In airports where there are inaccessible level changes, a temporary procedure must be implemented until such time as accessible elevators or similar devices can be installed.

A typical scenario might be that trailing platforms are moved on a one-by-one basis through the level change, with a motorized unit provided on each floor to continue the journey to and from boarding gates.

APPENDIX A

Figures - Testing

Fig. 10 Operator in driving position.

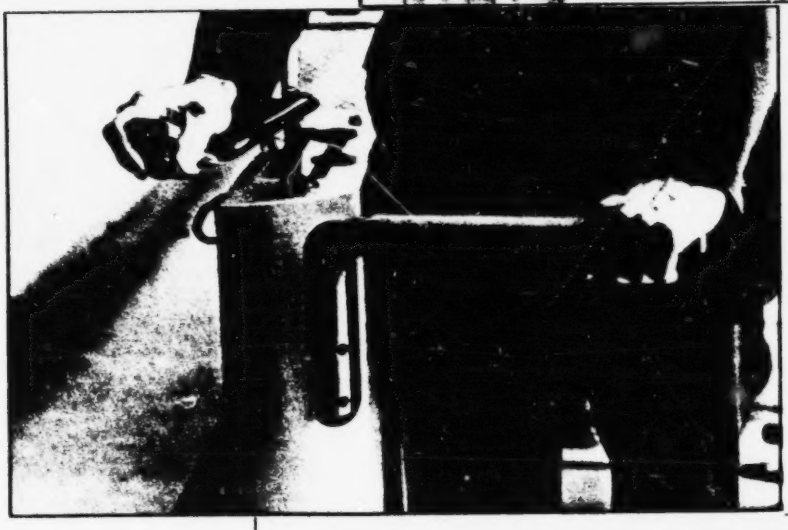


Fig. 11

Handsupport and tiller.

Fig. 12

Trigger on tiller for speed control.

Fig. 13 Operators using driver's perch as support.

Fig. 14

Operator folds seat in preparation for wheelchair access.

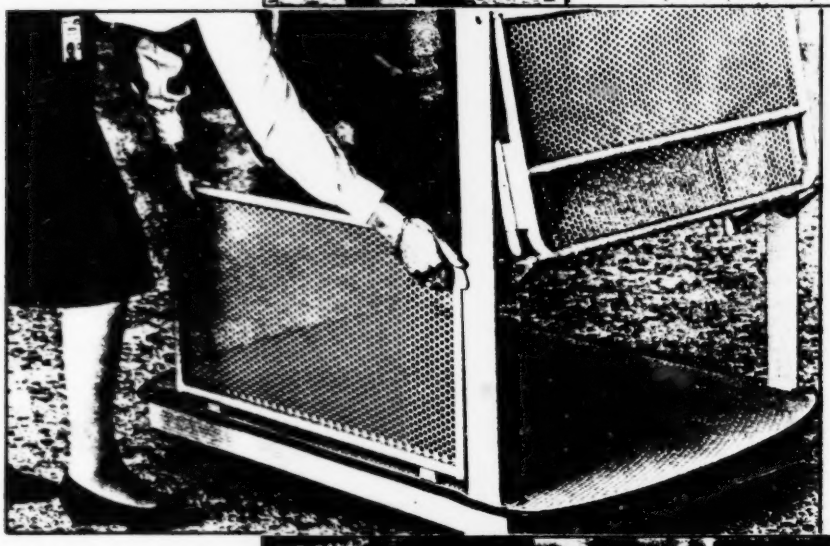
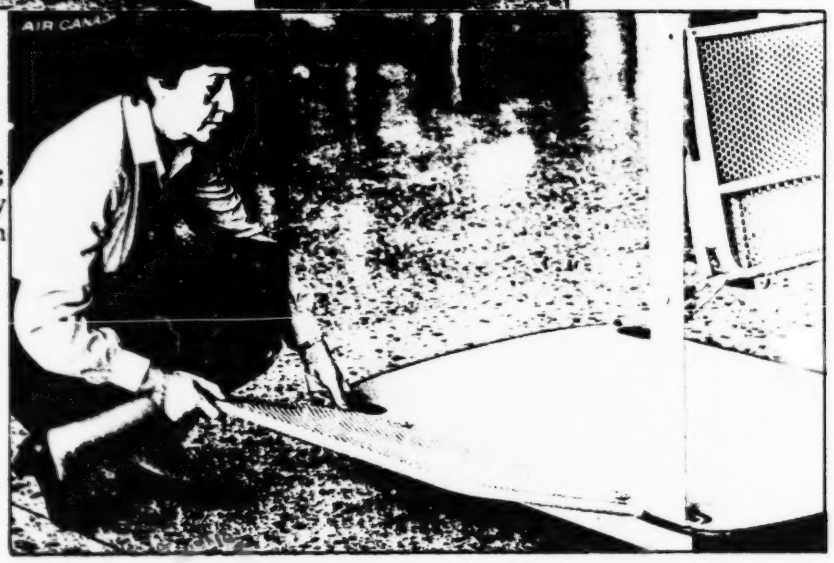


Fig. 15

Operator unlocks ramp.

Fig. 16

Operator releases ramp for wheelchair; kneels properly to avoid strain on back.



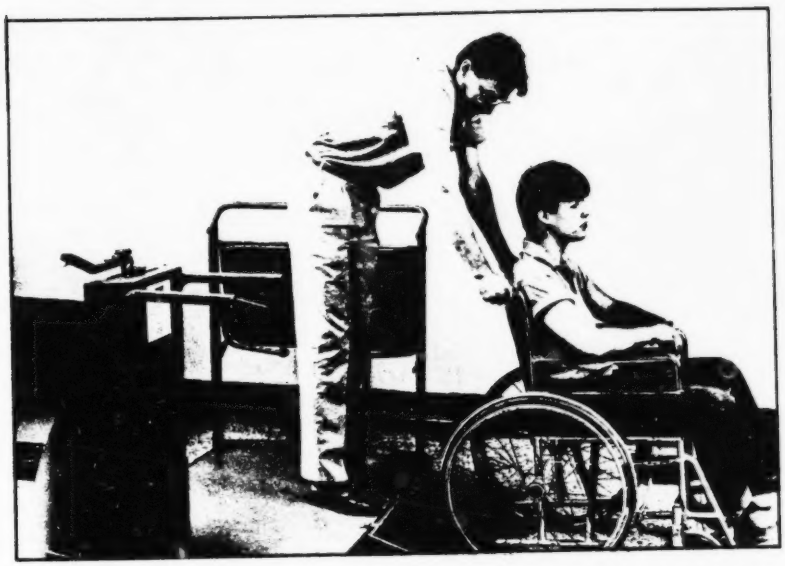


Fig. 17 Operator on platform to initiate wheelchair access.

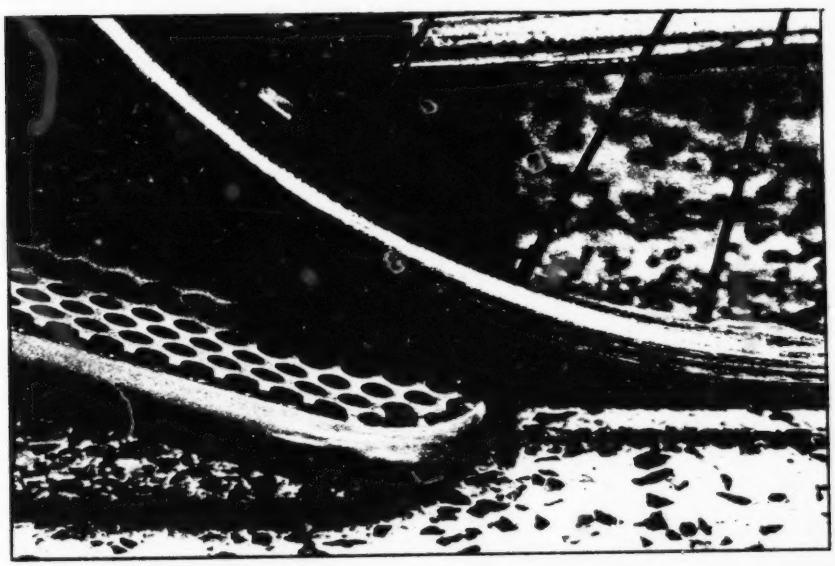


Fig. 18 Lip on ramp as a stop to tilt back wheelchair.

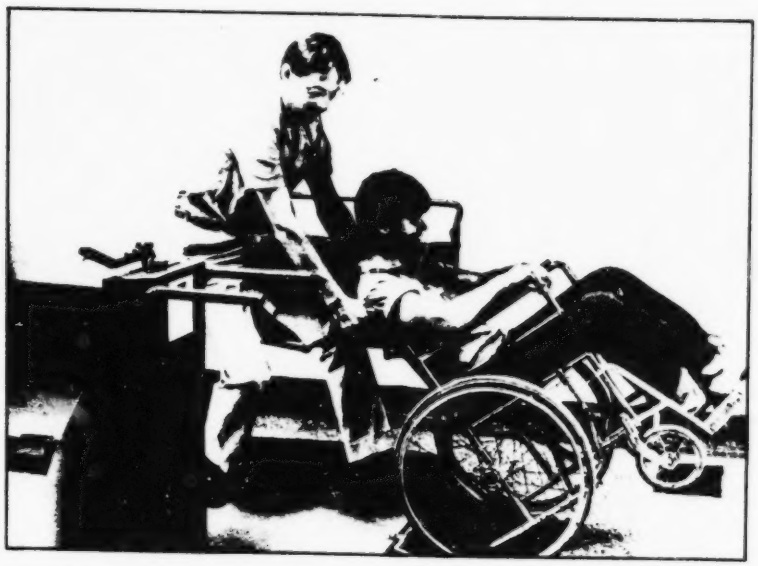


Fig. 19 Wheelchair passenger's weight is over axle for minimum strain on operator.

Fig. 20 Operator steps down and backs wheelchair against folded seat.

Fig.21

Operator drives through
door at security check
in Dorval Airport.

Fig. 22 Operator picks up passenger with small child.

Fig.23 Passenger with child secured by lap belt.

Fig. 24 Passenger with child being driven to departure gate at Dorval airport.

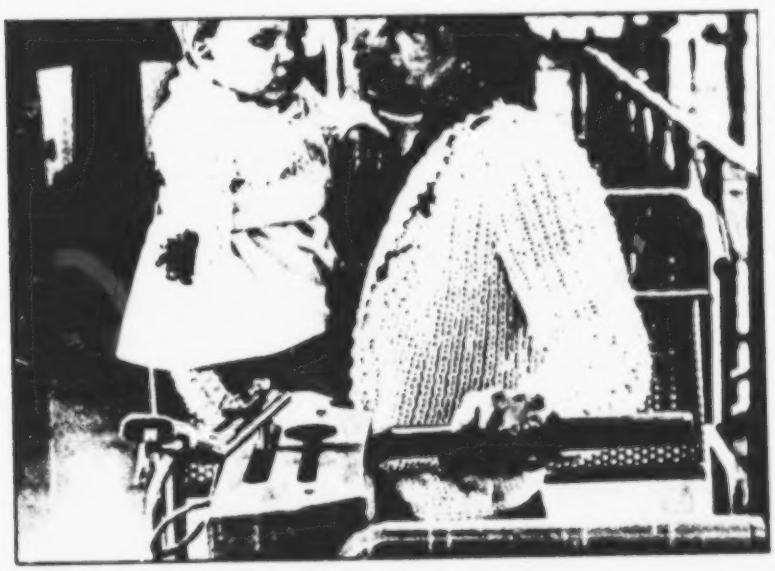


Fig. 25 Passenger using driver's perch as support to access and egress seat.

Fig. 25 Passenger with crutch accessing platform; using backrest as additional hand support.

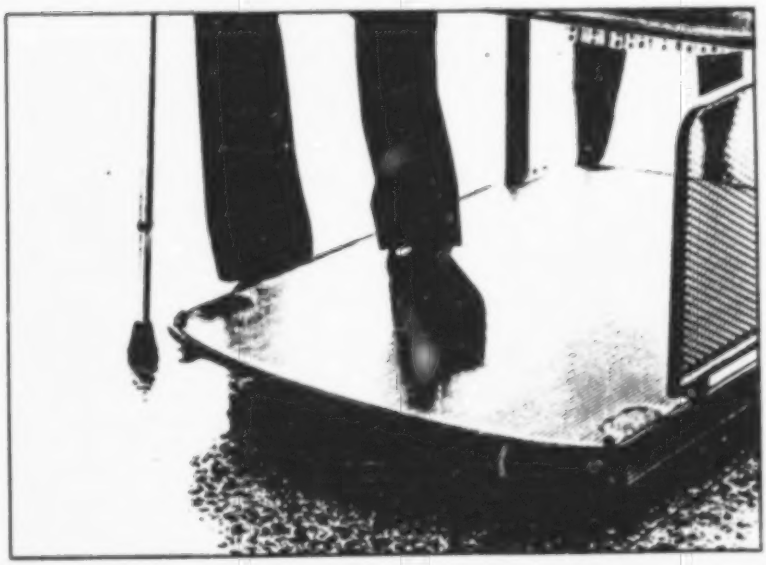


Fig. 27 Low platform height and vinyl mat allow for secure access to platform.

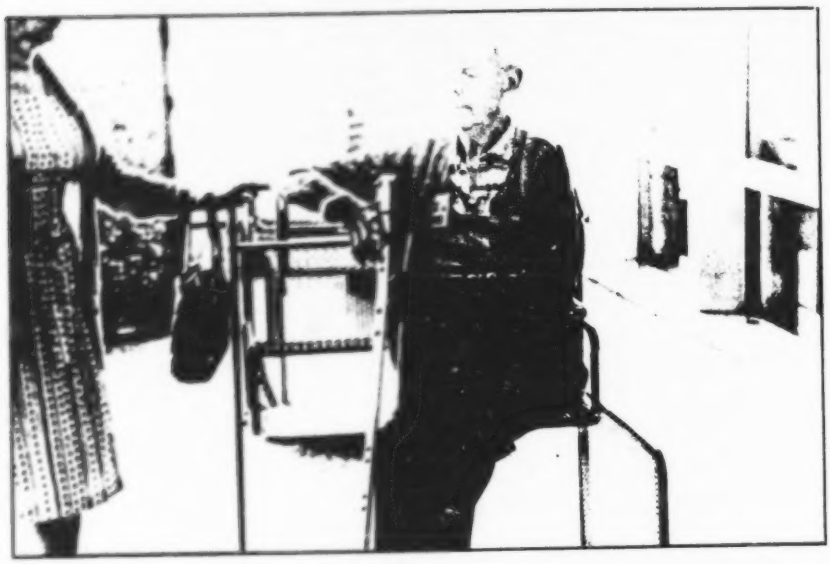


Fig. 28 Passenger with crutch seated on non-motorized platform with spouse assisting.

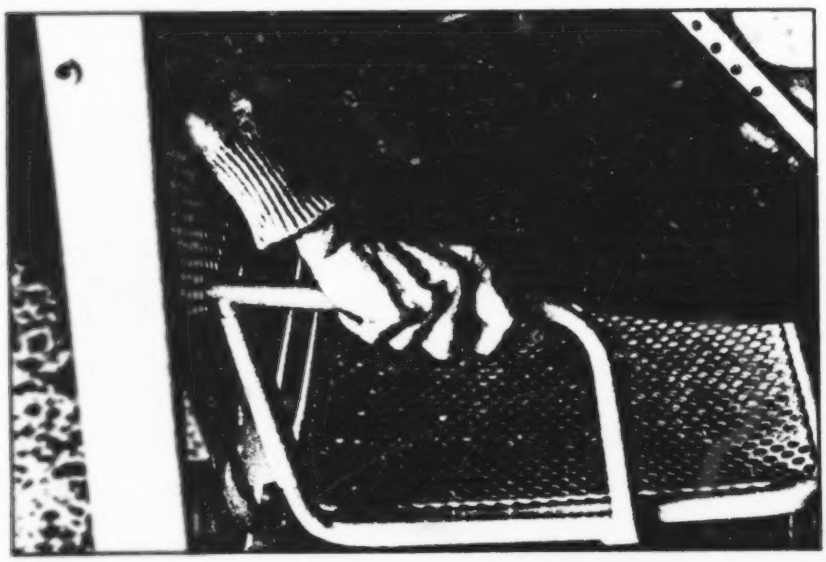
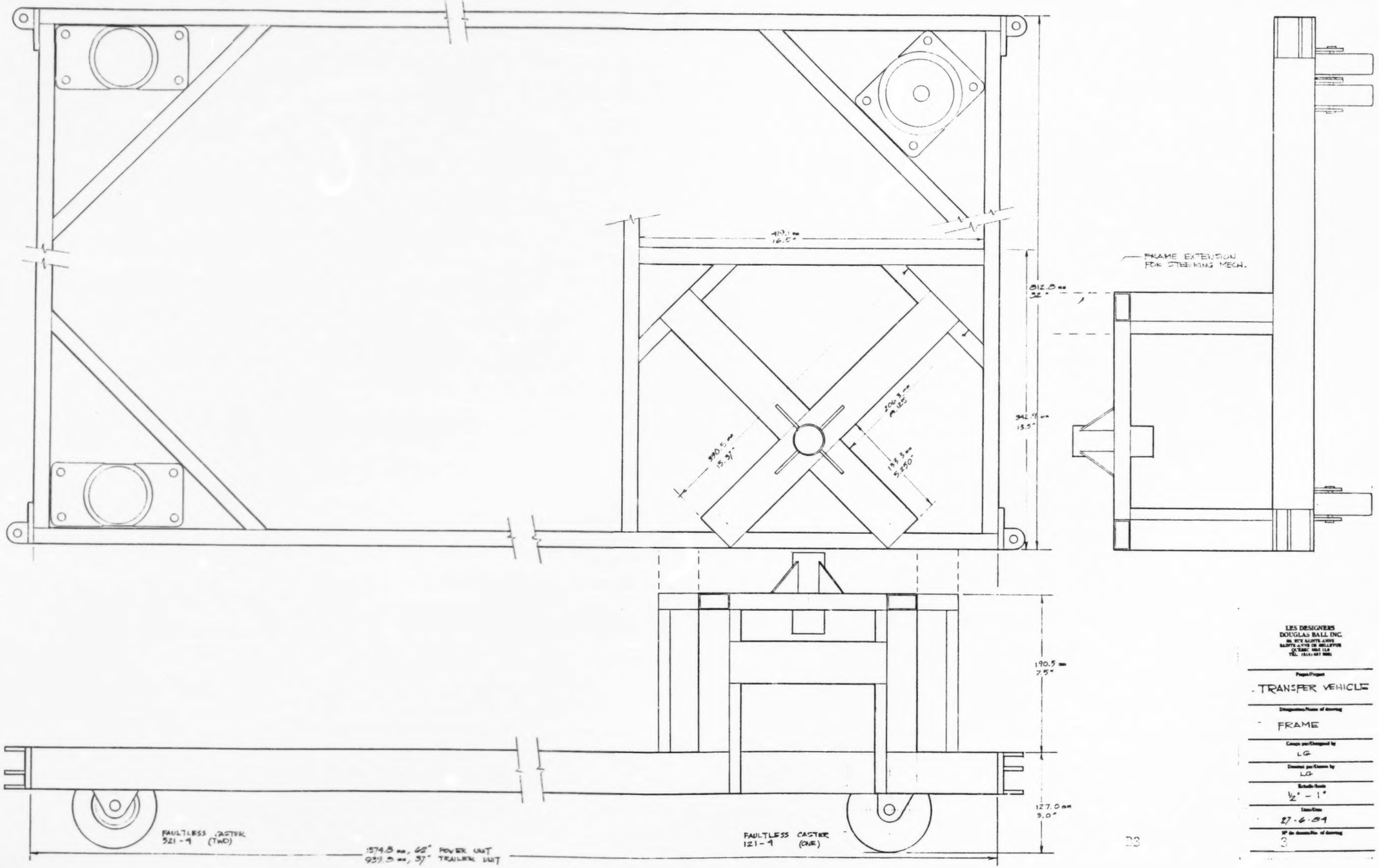


Fig. 29 Armrest as support to get in and out of seat.

APPENDIX B

Preliminary Drawings



LES DESIGNERS
DOUGLAS BALL INC.

Project/Projet
TRANSFER VEHICLE

Designation/Name of drawing
FRAME

Design par/Designed by
LG

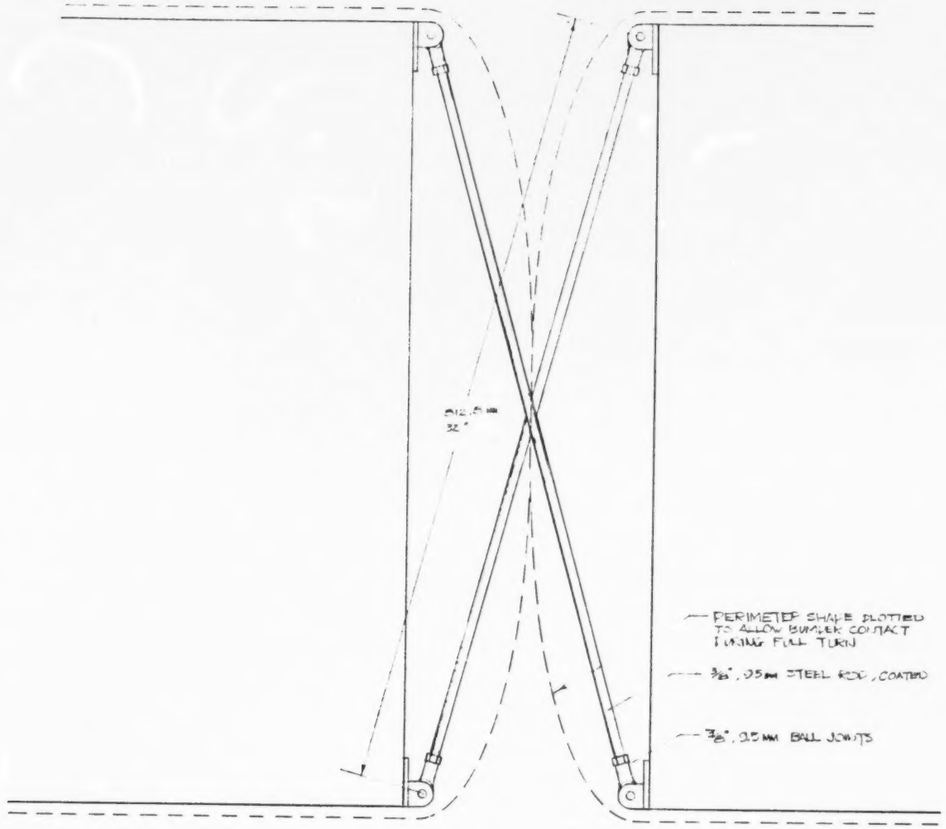
Dessiné par/Drawn by
LG

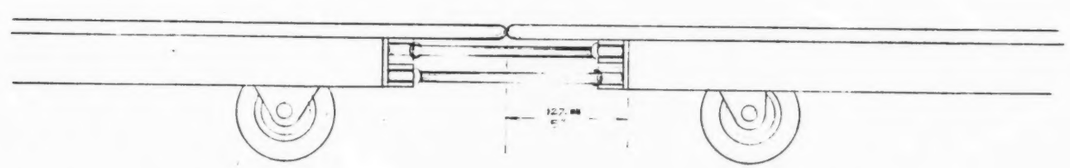
Echelle/Scale
½" - 1"

Date/Date
27-6-89

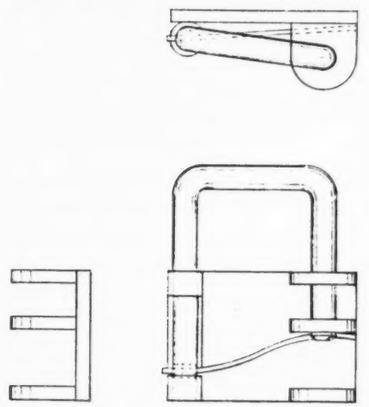
N° de dessin/No. of drawing
3

D3





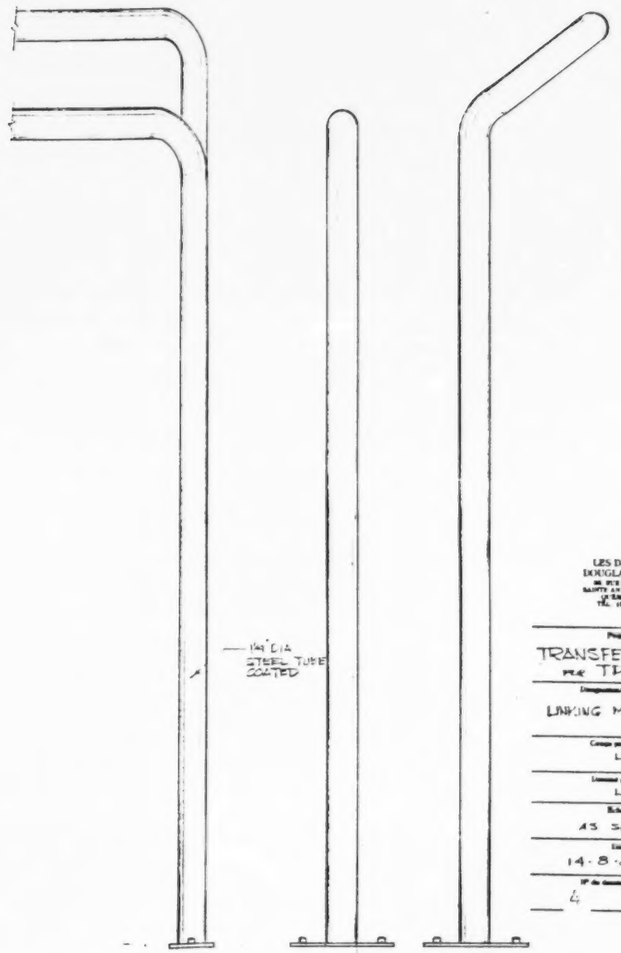
UNIT LINKING MECHANISM 1 3/8"-1"



LINKING MECHANISM ATTACHING POINTS

QUICK RELEASE SHOWN, BOLT SUBSTITUTED IF NO QUICK RELEASE REQ'D.

FULL SCALE



FRONT VIEW

FRONT END BAR FOR BAGGAGE CARRIER

⅝"-1"

PUSH HANDLE FOR CONNECTING TRAILER UNIT INTO BAGGAGE CARRIER

FITS INTO PLACE OF FOLDING SEAT

LES DESIGNERS
DOUGLAS BALL INC

TRANSFER VEHICLE
FOR TTC

LINKING MECH & DETAILS

LG

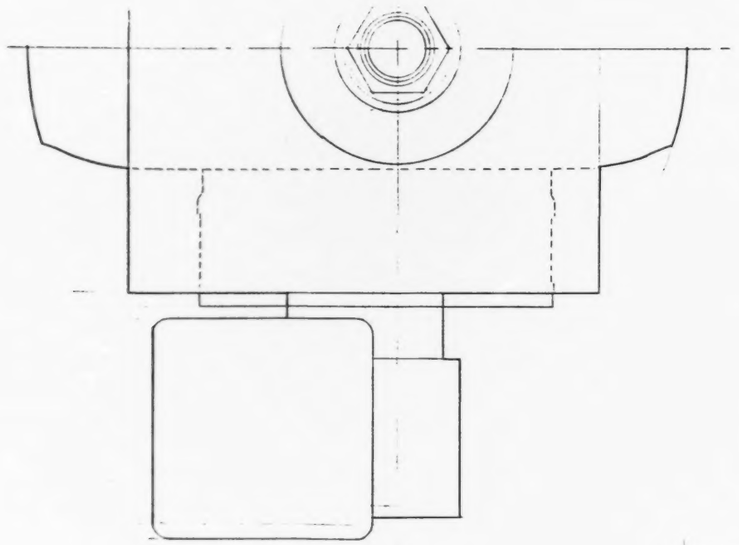
LG

AS SHOWN

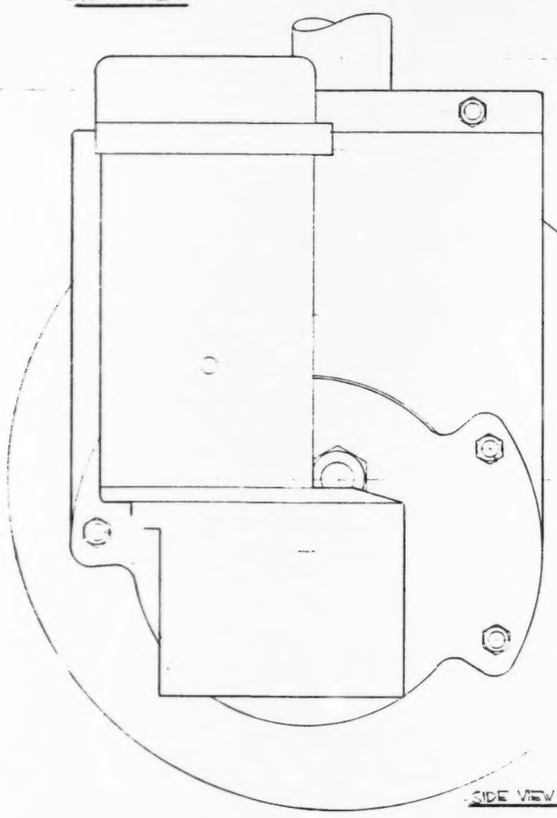
14-8-83

4

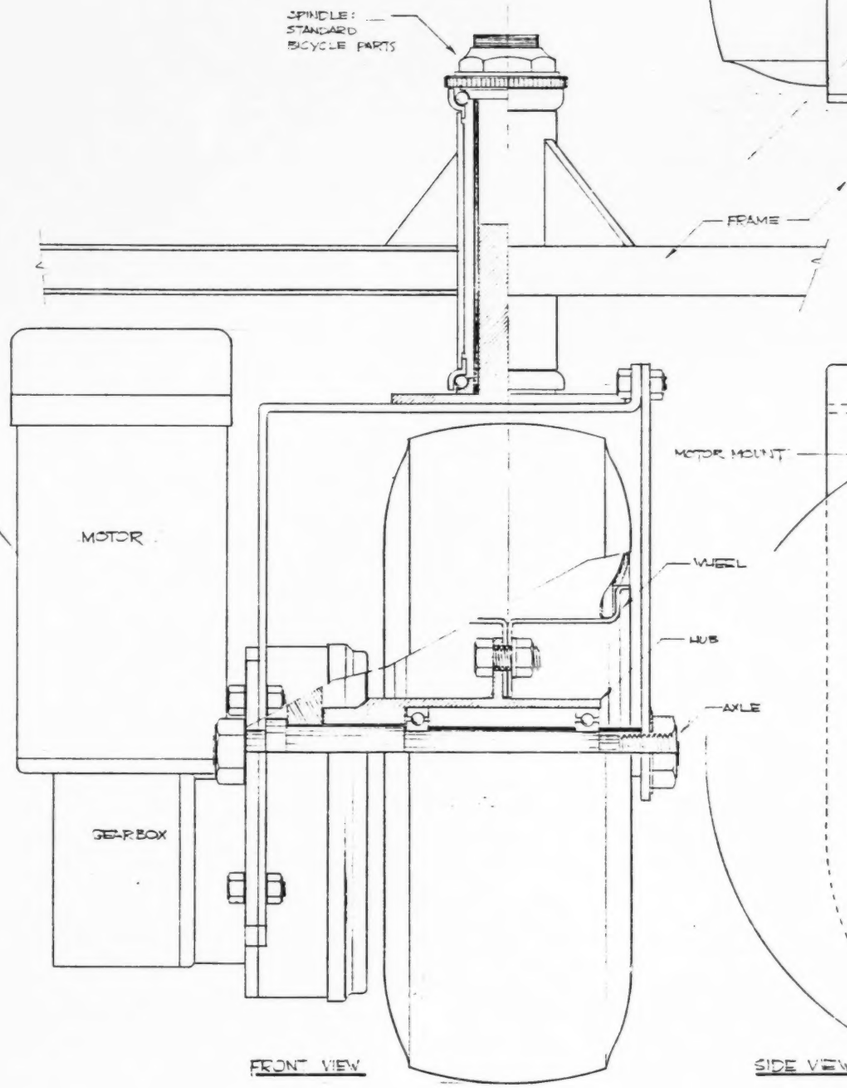
T.J



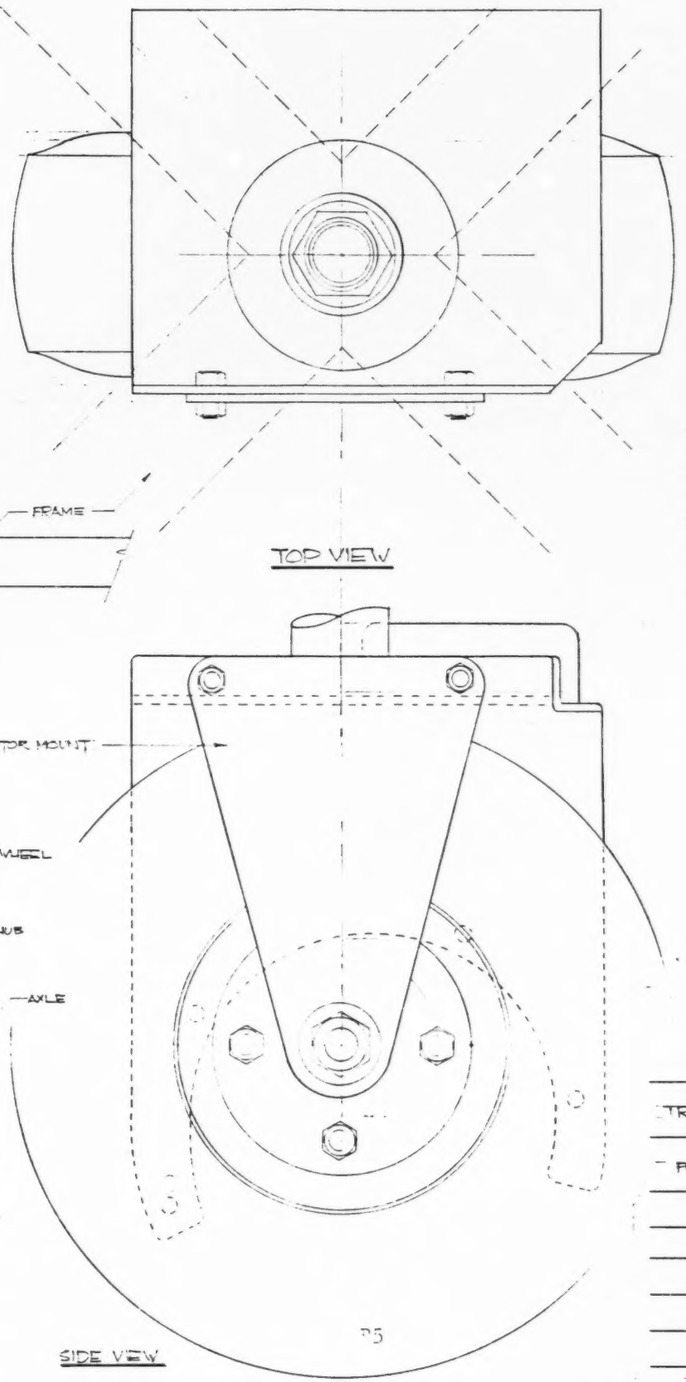
TOP VIEW



SIDE VIEW



FRONT VIEW



TOP VIEW

SIDE VIEW

NOTE:

ALL DIMENSIONS TO SUIT COMPONENTS USED, IE. MOTOR - CETOMELIA I HP ST 76140 (24 V, 150 W) EVERETT - JENNINGS) PUEUMATIC TIRE - 3.50/4.00 x 4

NEW HUB + AXLE REQ'D. TO ADAPT WHEEL TO GEAR BOX

LES DESIGNERS
DOUGLAS BALL INC.
[illegible]

Project/Projet
TRANSFER VEHICLE
TDC

Designation/Nature of drawing
POWER TRAIN LAYOUT

Design par/Designed by
LG

Dessiné par/Drawn by
LG

Echelle/Scale
FULL

Date
7-8-84

N° de dessin/No. of drawing
5

FRAME

STEERING LEVER

LOCKING KNOB FOR SLIDING STEERING WHEEL ADJUSTMENT

SLIDING BLOCK

34x2 TUBE FRAME TO SUPPORT STEERING PECH

UNIVERSAL JOINT (2)

NYLON CLIP TO HOLD ARM IN FOLDED POSITION

MOULDED FIBERGLASS COVER

ELECTRONIC CONTROL BOX

REMOVEABLE ACCESS PANEL

BATTERY (2 x 12 V.)

FLOOR MAT BUMPER AREA

VINYL EXTRUSION

RUBBER MAT

SEAT WELL - FORM METAL TO TUBE FRAME

FRONT VIEW SEAT FOLDED

FOLDED POSITION OF SEAT

FOLDED SEAT CLEARANCE FOR WHEELCHAIR WHEELS

FROM SEAT

LOCK FOR RAMP

LES DESIGNERS
DOUGLAS BALL INC.

TRANSFER VEHICLE
mod. TDC

ASSEMBLY DWG

LG

LG

3/8" = 1"

13.8.84

1

VINYL EXTRUDED BUMPER

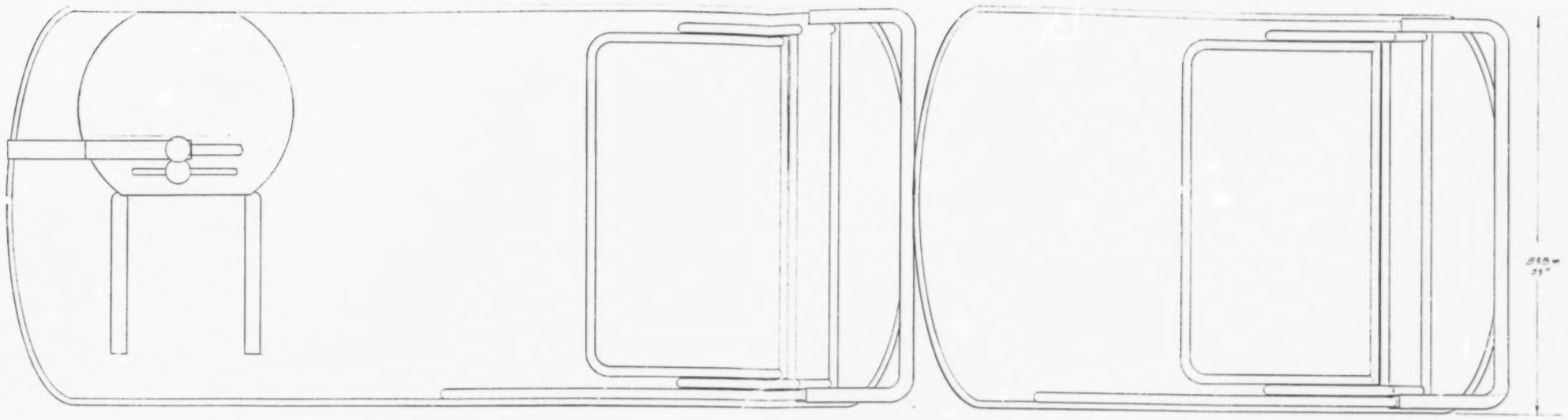
RUBBER MAT

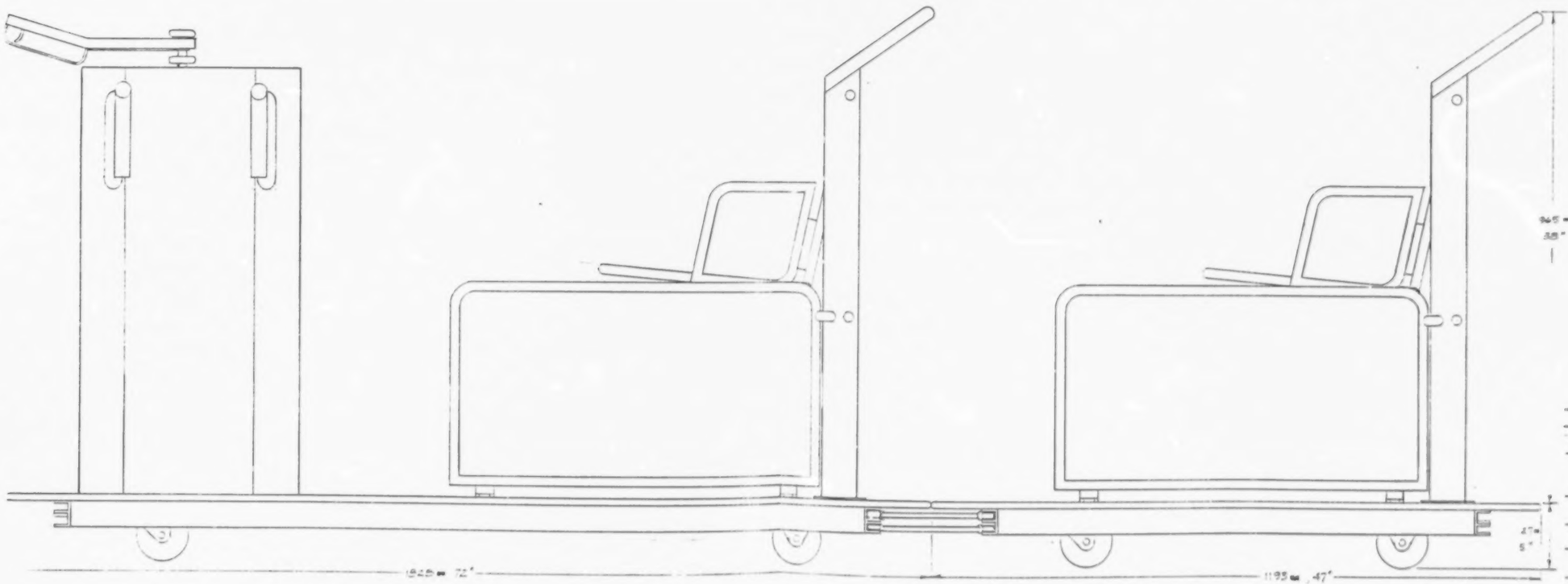
FRAME TUBE

FLOOR PLATE

FIBER MAT

1





POWER UNIT

TRAILER UNIT

LES DESIGNERS
DOUGLAS BALL INC.

TRANSFER VEHICLE
MOD. TDC.

GENERAL LAYOUT

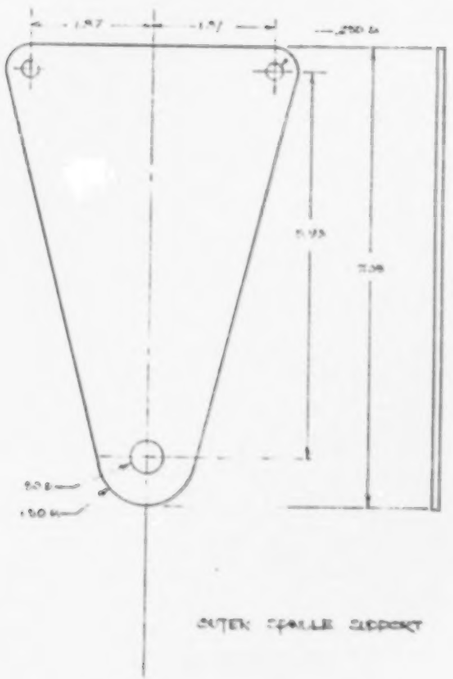
LG

LG

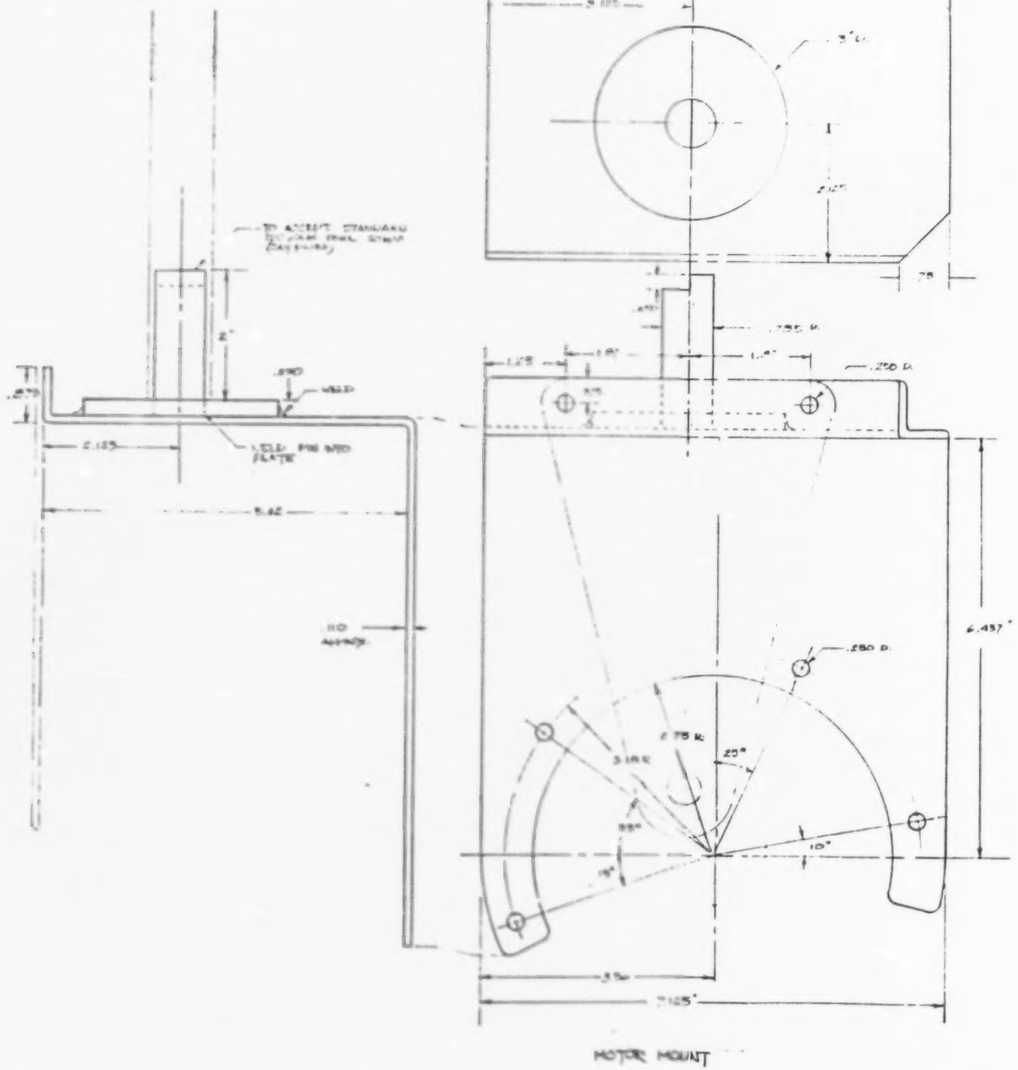
1/4" - 1"

15-8-89

12



OUTER SPOOLIE SUPPORT



MOTOR MOUNT

LES DESIGNERS
DOUGLAS BALL INC.

TRANSFER VEHICLE

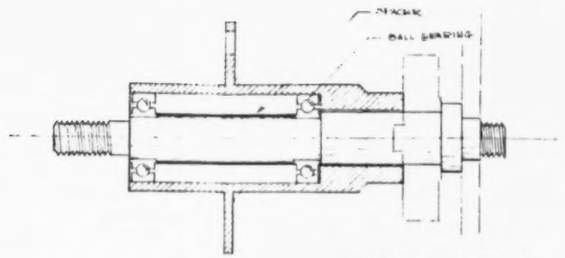
MOTOR MOUNT

LG

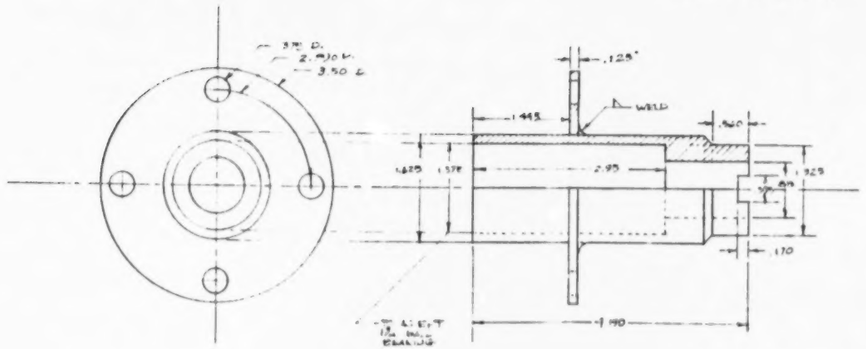
LG

FULL

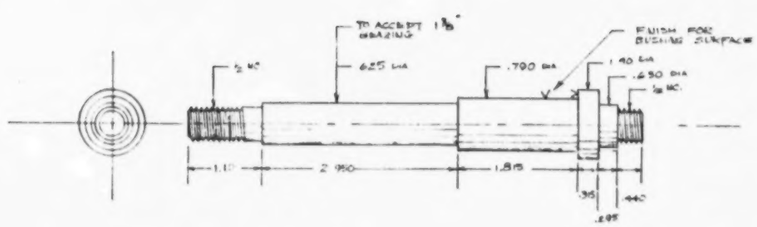
Page : 7/8.4



ASSEMBLY OF COMPONENTS



HUB



AXLE

LBS DESIGNERS
DOUGLAS BALL INC.

TRANSFER VEHICLE

HUB/AXLE - DRIVE UNIT

LB

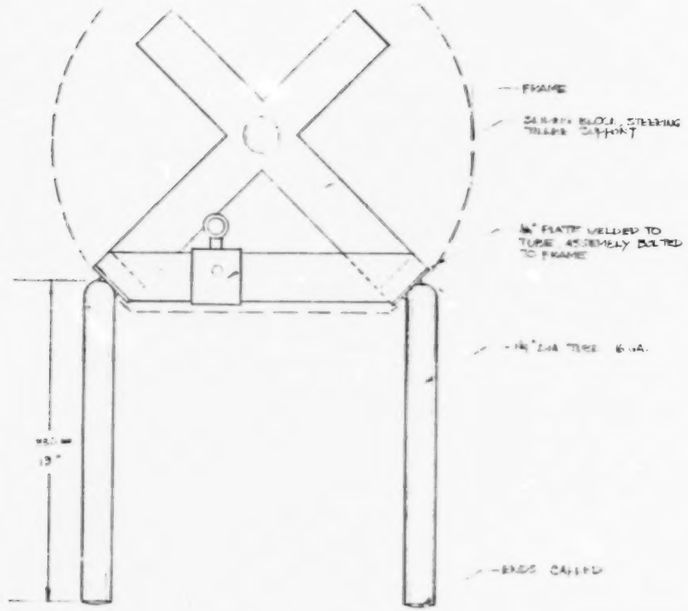
LB

FULL

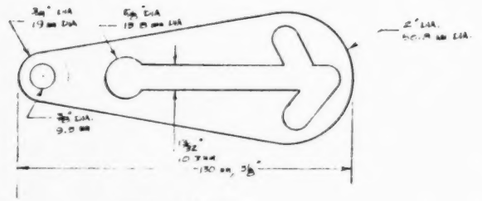
FEB 9/84

7

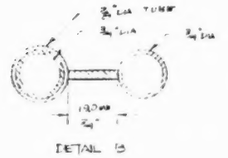
D7



TOP VIEW

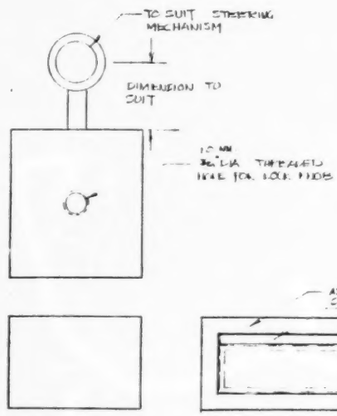


SEAT LATCH
DETAIL A



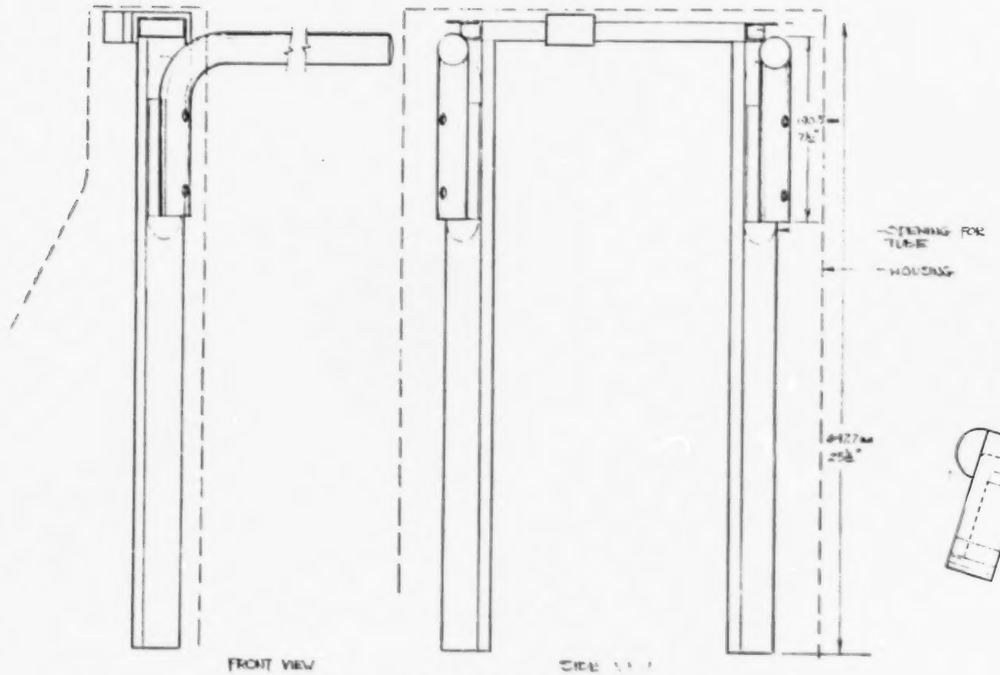
DETAIL B

DETAIL C



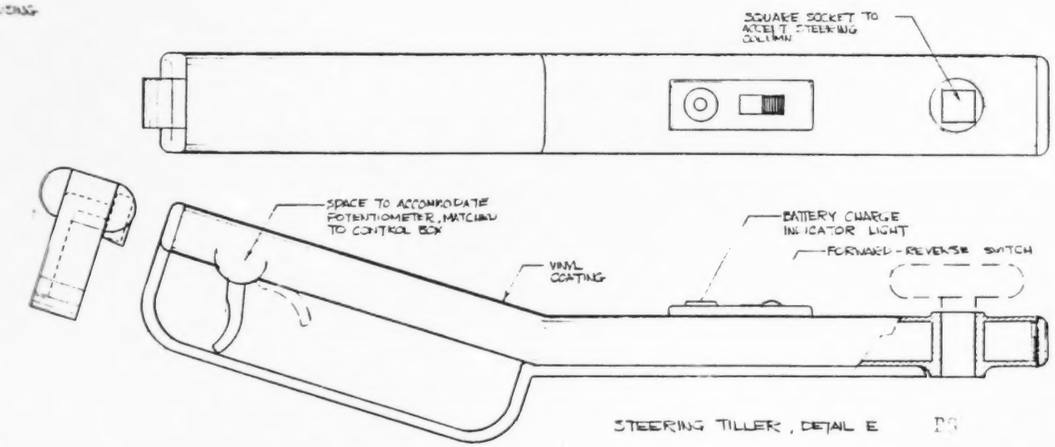
FULL SCALE

SLIDING BLOCK, TILLER ADJ. DETAIL D.



FRONT VIEW SIDE VIEW

DRIVER SUPPORT (PERCH) SCALE 3/4" = 1"


SQUARE SOCKET TO ACCEPT STEERING CYLINDAR
SPACE TO ACCOMMODATE POTENTIOMETER, MATCHED TO CONTROL BOX
VINYL COATING
BATTERY CHARGE INDICATOR LIGHT
FORWARD - REVERSE SWITCH

STEERING TILLER, DETAIL E

LES DESIGNERS
DOUGLAS BALL INC.

TRANSFER VEHICLE
TEC

DETAILS

LG

LG

14-8-84

8

APPENDIX C

Technical Description

MOTORIZED UNIT

Frame

19.5 mm x 50.8 mm (0.75" x 2.25"), 16 GA welded steel tubing, perimeter frame with corner reinforcing, welded construction. 812.8 mm x 1524 mm (32" x 60"), overall dimensions.

Platform

11 mm (0.50") B.C. fir plywood or 3.1 mm (0.125") aluminum sheet screwed to frame.

Seat Back

19.5 mm (0.75") diameter, 16 GA welded steel tubing bent and welded with perforated metal seat and back, 9.5 mm (0.375") perforations, 20 GA. Seat folds up against backrest, entire unit pivots back to clear wheelchair.

Seat Support Structure

Flat oval steel tubing 19.5 mm x 69.8 mm (0.75" x 2.75") 16 GA uprights bolted to frame. 25.4 mm (1") diameter tubing joining uprights at top forming a push handle.

Armrest

19.5 mm (0.75") diameter steel tubing, folding flat when seat is up.

Floor

Ribbed rubber mat 3 mm (0.125") thick glued to plywood.

Ramp

19.5 mm (0.75") diameter steel tube frame, perforated metal fill, same configuration as seat. Hinged to platform, folding up flush to structure uprights, retained by latch.

Tie-down

Hook attached to flexible line passing through fixture at floor level, containing a pawl. Tension on line pulls wheelchair against folded seat.

Bumper

Extruded vinyl tubular section attached to perimeter of platform.

Dimensions

Overall dimesnions, 838.2 mm wide x 1803.3 mm long x 1079.5 mm high (top of seat handle) and 133 mm to top of platform (33" x 71" x 42.5" and 5.25" to top of platform).

Power Section

Motor

24 volts, 250 watts, permanent magnet in waterproof case, 115 ft/lbs @ 160 rpm drawing 16 amps.

Wheels

101 mm (4"), casters, one swivel left front and two fixed in rear.

Drive Wheel

104/88 mm x 101 mm (4.10"/3.50" x 4") pneumatic tire on 101 mm (4") diameter steel wheel, with integral internal expanding drum brake.

Gear Box

Integral with motor case with worm gear and spur gear drive with final ratio of 2:1.

Tiller

At waist level with fore and aft adjustment and removable to rotate position 180°. Variable speed controlled by trigger. Forward/reverse switch and battery condition light also on tiller. Tiller connected to motor unit by vertical shaft with two universal joints.

Speed

Approximately 4 mph - depending on surface travelled and load carried.

Steering

180° change of direction of motor unit, pivoting on ball bearing supports.

Motor Housing

Single piece tower from floor to tiller of fiberglass. Access door for maintenance.

Batteries

Two 12 volts, acid or gel-cell, rechargeable batteries connected in series to supply 24 volts.

Charging

Regular automotive charger arranged to charge batteries in parallel (12 v.).

LINKING MECHANISM

Receivers on Platform

25 mm x 25 mm x 6.3 mm (1" x 1" x 0.25"), steel double brackets welded to frame at each corner.

Tie-Rods

9.5 mm (0.375") diameter steel rods, rubber covered.

Tie-Rod Ends

9.5 mm (0.375") ball-joint at each end of rod, with 9.5 mm (0.375") sliding pin or bolt to attach to receivers.

NON-MOTORIZED UNIT

Frame

the non-motorized unit is identical to the motor unit, except for the motor package, and having two swivelling casters in front. Seating, ramp and linking arrangement are the same. Dimension of frame is 812.8 mm wide x 1079.5 mm long (32" x 42.5").

Overall dimensions: 838.2 mm wide x 1803.3 mm long x 1079.5 (33" x 71" x 42.5"), 133 mm (5.25") to top of platform.

FINISH

All wood parts sealed and painted with primer. All metal frame parts primed and painted. All seating, seat structure and ramps are powder coated. Motor housing is fiberglass with a coloured gel-coat.